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Worst Case Impact Evaluation for the Proposed Interim Expansion for the Lamefoot Mine

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Hydro-Geo Consultants, Inc.
March 1998

Appendix B: Hydrology Modeling
Adrian Brown Consultants
March 1998

Appendix C: Geochemical PHREEQC Modeling
C 1 – Model Input
C 2 – Model Output

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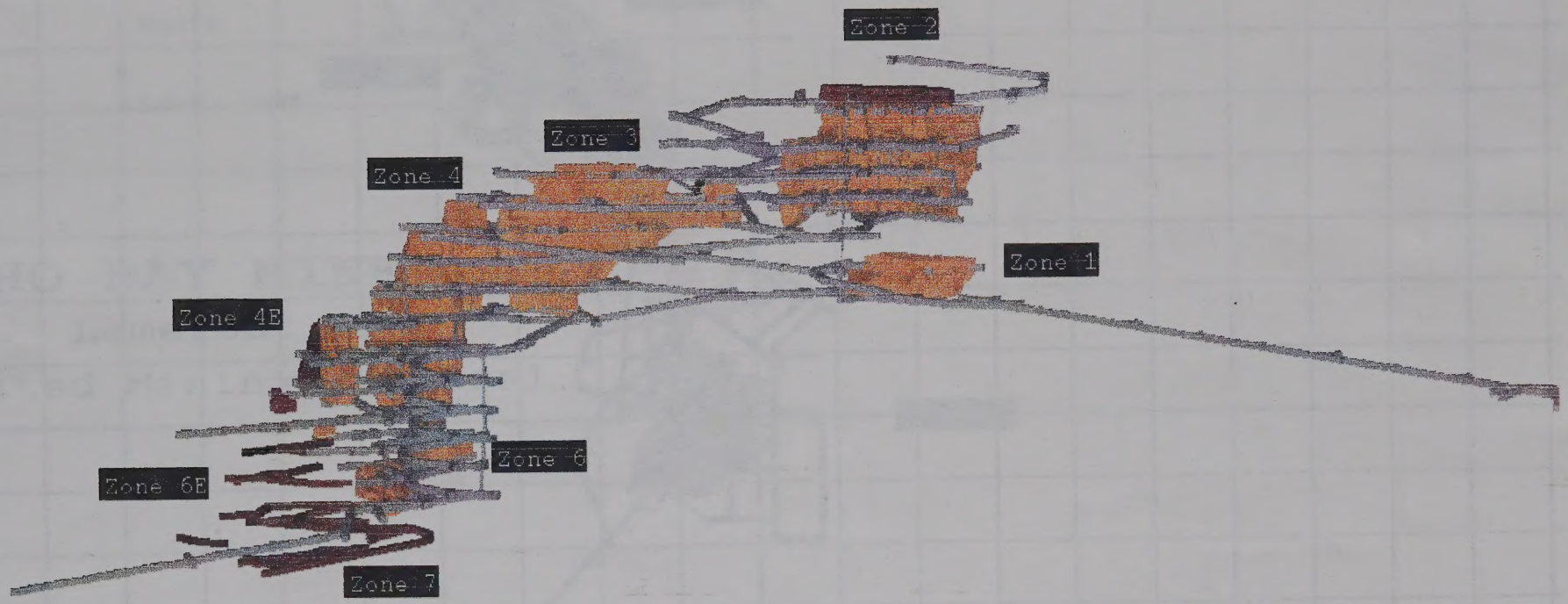
1.0 Introduction

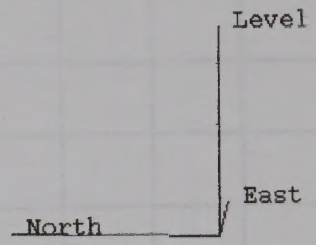
Several hydrologic and geochemical studies and modeling efforts have been performed in the past 3 years to determine the potential impacts on water resources associated with mining activities at the Lamefoot Mine. These include the 2750 Report (July 1995), Impact Evaluation (July 1995), Revised Impact Evaluation (May 1997), as well as several Technical Memoranda addressing agency comments and concern. The findings of these efforts to date have been corroborative and determined that there would be no impacts to water resources associated with the Lamefoot Mine.

Recently, Echo Bay submitted an Interim Proposal for limited expansion of the currently permitted mine area (February 4 memo from Echo Bay to George Brown – BLM Spokane Office). This proposal encompasses a small amount of ore above the 3070 level in upper Zone 2 (between 7200E and 7600E; 25850N and 26400N; elevation 3085 to 3115 feet) and mining in Zone 4 extension (Zone 4E) and primary development only in Zone 6 extension (Zone 6E) (between 6500E and 7000E; 27500N and 27850N; elevation 1850 to 2650 feet) and approximately 1500 feet of ramp construction in Zone 7 (between 6400E and 7000E; 27100N and 28000N; elevation 1900 to 2225 feet). The proposed areas to be mined are shown in Plate 1 (cross-section) and Plate 2 (plan view). Development of Interim Proposal area would utilize the same mining methods, ore haulage, and processing as the current mining operation.

As part of this proposal, BLM has requested that the current impact evaluation (May 1997 and subsequent modeling efforts in response to BLM comments) be revised to reflect recent hydrologic information regarding mine inflow associated with the interim proposal.

This report addresses agency concerns via the incorporation of recent hydrologic information into an updated hydrologic mine inflow model (Adrian Brown Consultants (ABC)). Revised inflow values from the hydrologic model were then utilized in the updated geochemical model. The results from the geochemical model form the basis of the impact evaluation. It should be clearly understood that that the hydrologic and geochemical modeling represent a worst-case *bounding* condition which is more extreme than may be conservatively expected to occur. The purpose for employing this approach is to account for any foreseeable changes in hydrology or geochemistry which may occur and thereby preclude the necessity of repeated subsequent evaluations.



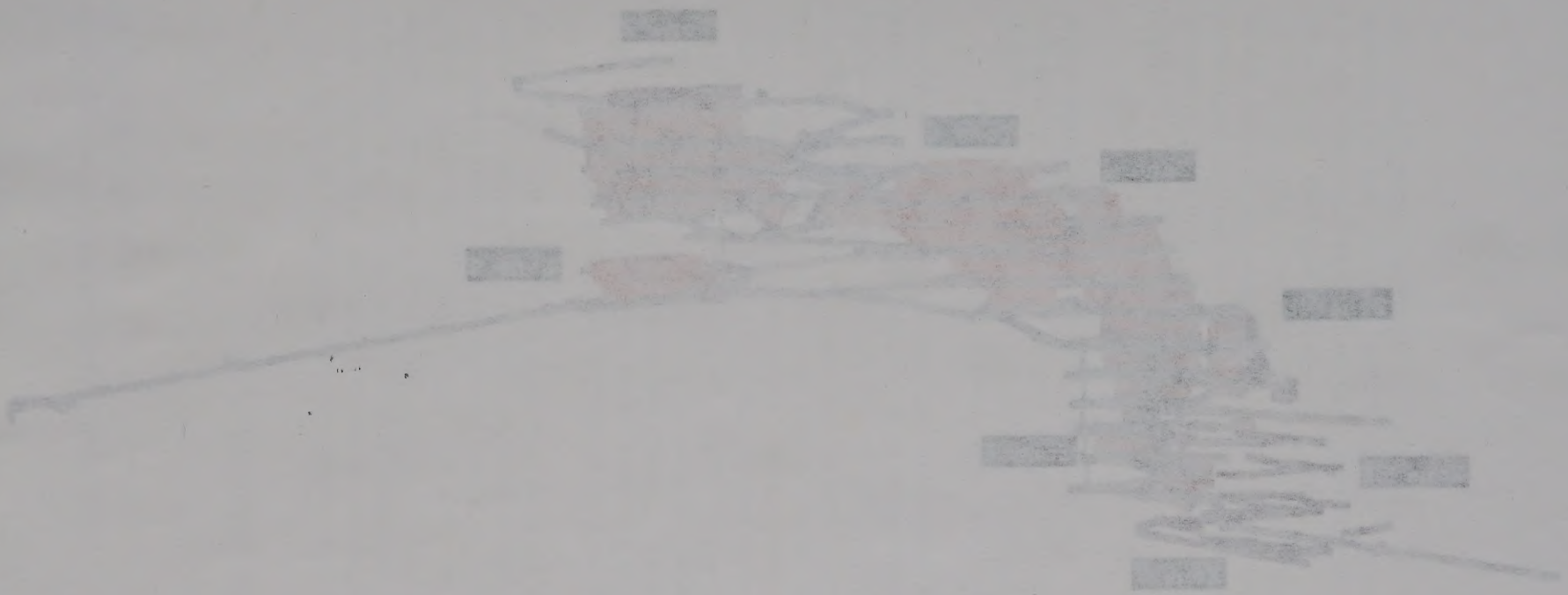


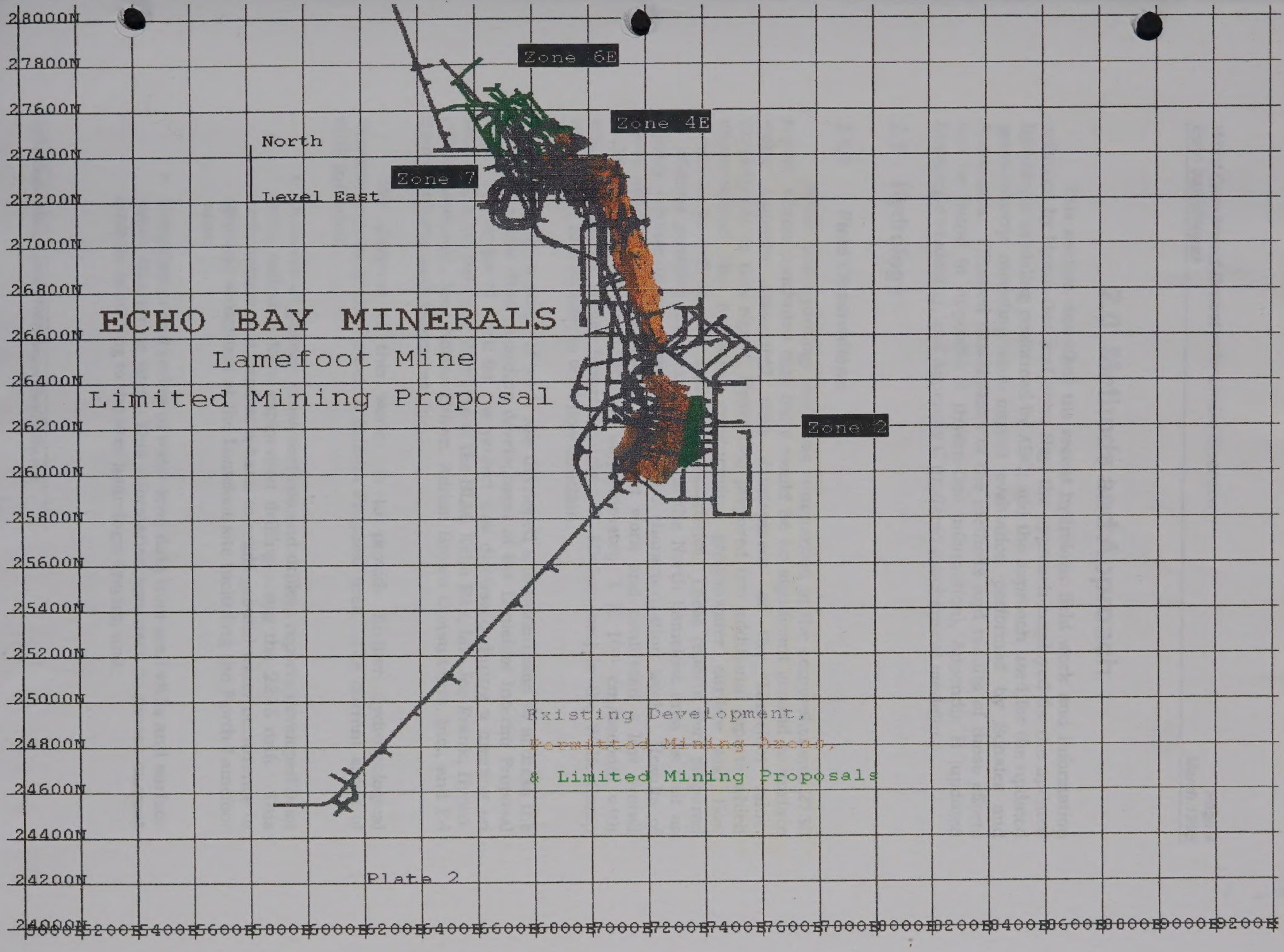
ECHO BAY MINERALS

Lamefoot Mine

Limited Mining Proposal

PLATE #1




ECHO BAY MINERALS
Lamefoot Mine
Limited Mining Proposal
Zone 6E
Zone 4E
Zone 7
Zone 2
North
Level East
Existing Development,
Permitted Mining Areas,
& Limited Mining Proposals
Plate 2
28000N
27800N
27600N
27400N
27200N
27000N
26800N
26600N
26400N
26200N
26000N
25800N
25600N
25400N
25200N
25000N
24800N
24600N
24400N
24200N
24000N

2.0 Methods and Approach

This section describes the recent hydrologic field work and information collected by Hydro-Geo and Echo Bay; the approach employed for the updated hydrologic modeling performed by ABC; and the approach used for the updated geochemistry modeling and impact evaluation performed by Schafer and Associates. Detailed descriptions of the methods and results of these efforts can be found in Appendix A (Hydro-Geo information), Appendix B (updated hydrologic modeling), and Appendix C (updated geochemical modeling).

2.1 Hydrology

2.1.1 Field Observations

Initial field hydrology work was summarized in the comprehensive 2750 report, which concluded that there would be no significant ground or surface water impacts associated with development at the Lamefoot mine. Subsequent to this report, Hydro-Geo prepared two additional reports which characterized the hydraulic conductivity, groundwater surface and flow direction, as well as other aquifer characteristics. These reports were prepared to address possible mine expansion into the North Lamefoot area as well as agency comments on previous hydrologic characterization work. Results of these studies were consistent with past work and confirmed a low overall rockmass hydraulic conductivity (approximately 1 X 10^{-6} cm/second) with somewhat higher values (approximately 6 X 10^{-4} cm/sec) in the Wolfe Camp Fault Zone, and an east to west flow direction.

Recently, a scope of work was developed and undertaken to address the concerns of the BLM regarding development of the Lamefoot Interim Proposal area. The scope of work for the project was discussed during a meeting on March 3, 1996 between members of the BLM, Echo Bay, Mr. Joe Frank, Hydro-Geo Consultants, Inc., Adrian Brown, Adrian Brown Consultants, Inc., and Ed Spotts, Schafer and Associates, Inc.

The purpose of this work is to provide further hydrogeological characterization of the Lamefoot Interim Proposal area. The current scope of work included:

- A review of geologic cross sections and drillers reports developed from data collected from exploration drilling along the 2225 drift. This information was used as a basis to relate ground water occurrence to geologic structures at the Lamefoot site including the North Lamefoot area;

- Compilation and review of water level data from area wells and surface water monitoring sites. This information was used to assess current impacts of mining to the area hydrologic system, and;

2.0 Methods and Approach

This section describes the recent hydrologic field work and information collected by Hydro-Geo and Golder Hydro this approach employed for the updated hydrologic modeling performed by [illegible], and the approach used for the updated geochemistry modeling and impact evaluation performed by Golder and associates. Detailed descriptions of the methods and results of these efforts can be found in Appendix A (Hydro-Geo Information), Appendix B (updated hydrologic modeling), and Appendix C (updated geochemical modeling).

2.1 Hydrology

2.1.1 Field Observations

Recent field hydrology work was summarized in the comprehensive 0750 report, which concluded that there would be no significant pondal or artesian water impacts associated with development at the Lamefoot Intern. Subsequent to this report, Hydro-Geo performed two additional reports which observed the hydrologic conditions, preliminary sources and flow rates as well as other aquifer characteristics. These reports were prepared to address possible main expansion into the North Lamefoot area as well as specific concerns on previous hydrologic characterization work. Results of these studies were consistent with past work and confirmed a low overall hydraulic conductivity (approximately 1 X 10⁻⁴ cm/second) with some higher values (approximately 2 X 10⁻³ cm/sec) in the Walls Camp Fault Zone, and on east to west flow direction.

Recently, a scope of work was developed and undertaken to address the concerns of the BLM regarding development of the Lamefoot Intern Proposed Area. The scope of work for the project was discussed during a meeting on March 5, 1990 between members of the BLM, Echo Bay, Mr. Joe Frank, Hydro-Geo Consultants Inc., Adrian Brown, Adrian Brown Consultants, Inc., and Ed Spong, Golder and Associates, Inc.

The purpose of this work is to provide further hydrogeologic characterization of the Lamefoot Intern Proposed Area. The current scope of work included:

- A review of geologic cross sections and drillers reports developed from data collected from exploration drilling along the 7225 drift. This information was used as a basis to relate ground water occurrences to geologic structures at the Lamefoot site including the North Lamefoot area;

- Compilation and review of water level data from area wells and surface water monitoring sites. This information was used to assess current impacts of mining to the area hydrologic system, and;

- Complete a detailed potentiometric surface map using current water level data and estimated drawdown near the mine development areas.

A detailed discussion of previous and current work is presented in Appendix A.

2.1.2 Modeling Approach

The impact of the proposed interim expansion to groundwater and to surface water resources has been evaluated, using the same modeling analysis method as was used for the impact evaluation and Finding of No Significant Impact presented in support of the earlier expansion of the mine below the 2,750 foot elevation.

The model used for computation of flows and impacts has been constructed using the known topography, geology, and meteorology of the area, including the two principal fault systems (the Wolfe Camp/Anfo Fault zone and the Curlew Fault zone), the known hydraulic conductivity of the different materials, and the heads measured on site and regional wells. Where there was uncertainty in any of the inputs, the values which would produce the maximum mine inflow and head impact were chosen from the measured ranges. The initial conditions predicted by the model have been calibrated against the observed water levels in the wells, by adjustment of hydraulic parameters of materials within their measured ranges. The model was then subjected to the hydrologic stresses imposed by mining, and the inflow and head response to mining was predicted. In order to determine the maximum possible flow and impact, it was assumed for this analysis that the crown pillar was disturbed by mining, and was assumed to have infinite hydraulic conductivity. Finally, the modeled mine was allowed to refill with water to simulate worst-case post-mining conditions, making the further assumption that the mine backfill material also had infinite hydraulic conductivity.

2.2 Geochemical Modeling

The approach used for the geochemical modeling is consistent with that employed in the Revised Impact Evaluation (RIE) (May 1997) and subsequent modeling efforts in response to BLM comments. The public domain code PHREEQC was utilized. The approach is explained in detail in the May 1997 REI and summarized herein for convenience.

Flow rates into the mine are different during filling and after filling. During infilling, conditions are expected to be oxidizing, with somewhat less oxidizing conditions expected following mine filling. The geochemical model addresses both of these situations by using the appropriate mine inflow rates as well as inflow chemistry and model parameters for each case.

The same inflow water qualities were used for the RIE were used in the current modeling effort (Table 2.1) . The quality of water flowing into the mine laterally and through the top of the mine (crown pillar) were characterized separately to represent possible water quality changes as the result of the

desaturation of a portion of the crown pillar after mining. Past modeling efforts characterized flow through the post-filling saturated and desaturated portions of the mine crown pillar separately. To be consistent with the conservative, worst case bounding approach of this analysis, all flow through the crown pillar in the post filling scenario was modeled as occurring through the desaturated portion of the crown pillar. Lateral inflow is characterized by naturally neutralized ARD from the LF-120 seep. Inflow through the crown pillar is characterized by neutralized ARD from the 2875 seep. Inflow chemistry is presented in the input files in Appendix C.

Table 2.1. Analytical results for mine infilling solutions used for model input.

Parameter	Units	Neutralized ARD (2875 Seep)[1]	LFC-120 Seep	ARD (2875 Seep)	Wall Rock Rinse After Mixing[2]
Temp	°C	10	10	10	10
PH	s.u.	7.1	7.1	2.3	6.5
Eh	mV	284	-12	650	455
Charge Imbalance[3]	%	0.0	0.00	0.0	0.00
Ag	mg/L	0.010	0.005	0.1	0.005
Al	mg/L	0.030	0.100	256.0	0.938
Alkalinity	mg $CaCO_3$/L	550	334	2	17.3
As	mg/L	0.001	0.010	114	0.010
Ba	mg/L	0.100	0.100	0.1	0.100
Ca	mg/L	680	374	362	179
Cd	mg/L	0.003	0.001	0.32	0.028
Cl	mg/L	1.00	9.00	1.0	3.82
Cu	mg/L	0.570	0.010	1300	1.07
F	mg/L	--	0.330	--	0.177
Fe	mg/L	0.020	20.5	8500	4.60
K	mg/L	1.00	3.00	1.0	4.90
Mg	mg/L	308	86.0	266	370
Mn	mg/L	3.15	0.270	13.0	1.94
N	mg/L	--	0.222	--	237
Na[3]	mg/L	87.3	1.16	594	127
Ni	mg/L	0.070	0.010	0.48	0.184
Pb	mg/L	0.001	0.010	0.13	0.010
Si as H_4SiO_4	mg/L	--	48.0	--	--
SO_4	mg/L	2560	978	22000	1910
Zn	mg/L	1.60	0.020	69.56	2.26

Notes:
1. *From ABC neutralization testing (2750 Report, ABC et al., 1995).*
2. *Final solution composition after mixing WR-1,WR-2,WR-3,WR-4, and WR-5 (wall rock rinsates-2750 report).*
3. *Analytical sodium concentration adjusted to achieve charge balance*

desaturation of a portion of the crown pillar after mining. Past modeling efforts characterized flow through the post-filling saturated and desaturated portions of the mine crown pillar separately. To be consistent with the conservative, worst case bounding approach of this analysis, all flow through the crown pillar in the post filling scenario was modeled as occurring through the desaturated portion of the crown pillar. Lateral inflow is characterized by naturally saturated AMD from the 1320 area. Inflow through the crown pillar is characterized by neutral load AMD from the 1875 area. Inflow chemistry is provided in the input files in Appendix C.

Table 2.1. Analytical results for sulfate fulfilling solutions used for model input.

pH	S.U.	10	10	10	10
Eh	mv	7.1	7.1	2.3	6.5
Temp	deg C	24.4	12	0.60	4.85
Alkalinity	%	0.0	0.04	0.0	0.00
Al	mg/L	0.010	0.073	0.1	0.005
Ca	mg/L	0.020	0.103	258.0	0.829
Acidity	mg CaCO3/L	280	3.24	2	14.3
As	mg/L	0.024	0.218	174	0.016
Ba	mg/L	0.100	0.100	0.1	0.100
Cl	mg/L	680	374	302	170
Co	mg/L	0.004	0.001	0.22	0.028
Cr	mg/L	1.20	5.00	1.0	3.43
Cu	mg/L	0.070	0.010	1000	1.07
F	mg/L	—	0.250	—	0.172
Fe	mg/L	0.020	20.5	1000	2.50
K	mg/L	1.00	3.00	1.0	1.30
Mg	mg/L	300	98.0	200	370
Mn	mg/L	3.13	0.270	13.0	1.94
Na	mg/L	—	0.220	—	2.27
Ni	mg/L	0.13	1.32	004	127
Pb	mg/L	0.070	0.010	0.43	0.184
Zn	mg/L	0.007	0.070	0.13	0.010
Sulfate H_2SO_4	mg/L	—	48.8	—	—
SO_4	mg/L	2900	974	2,000	1910
Zn	mg/L	1.80	0.024	69.56	2.20

Notes:

1. From ABC field solution testing (2000 Gerald ABC et al., 1995)
2. Final solution concentration after mixing WP-1, WP-2, WP-3 WP-4 and WP-5 (see mixing calculation report)
3. Analytical results concentration adjusted to fit solution charge balance

The water quality of the mine inflows is conservative in light of the copious geochemical data (static tests, humidity cells, scanning electron microscopy) and water quality (drip surveys, groundwater monitoring) which indicate an alkaline system. This information has been presented and discussed in detail in several documents including the 2750 Report, Impact Evaluation and Revised Impact Evaluation. Similarly, the justification of the inflow water chemistry used in the geochemical modeling was presented in the RIE and subsequently discussed in detail in an October 9, 1997 technical memorandum which addressed BLM comments on the RIE.

The percentage of each of these sources flowing into the mine was taken from ABC's updated hydrologic modeling (Appendix B). The conditions modeled were those which predicted the worst water quality in the original RIE modeling effort (i.e. Eh = 0 mv; pCO_2 = -2.5, no additional ferrihydrite precipitates).

Although the *amount* of lateral and crown pillar inflow has increased in the updated hydrologic model, the percentage of total flow comprised by each of these sources remained unchanged relative to previous inflow values for the *during filling* case. There is therefore no change in predicted water quality as the mine fills relative to the RIE. Results of this analysis are nonetheless provided for completeness. Similarly, previous analyses of backfill neutralization potential are still germane and remain conservative. Backfill neutralization potential was evaluated and summarized in an October 9, 1997 technical memorandum by Schafer and Associates. For the scenarios modeled, one million tons of backfill, all characterized as potentially acid generating (PAG) , was added to the mine and the mine was arbitrarily allowed to fill with ARD. The model also accounted for passivation (coating) of limestone, which reduces neutralization potential (from 50 % to 85 %). Even under such unlikely conditions, the backfill provided ample neutralization potential.

why no change?

misloading

The updated hydrologic modeling did predict that the percentage of inflow through the crown pillar *after filling* decreases somewhat relative to the original model. The geochemical model was thus updated to reflect this change. A summary of the geochemical modeling approach is presented in Table 2.2. The reader is referred to the Revised Impact Evaluation for a detailed description of the geochemical modeling approach.

why?

1997 - 48% (11 gpm) C.P
52% walls

see oct. model rept.

change in Q from oct. run?

post mining 72.7% thru C.P
8 gpm
27.3% thru walls
3 gpm

new 38 gpm total
47.4% thru C.P
18 gpm
52.6%
20 gpm walls

aft filling 75 gpm total
68% thru C.P
32% walls
8 gpm

Table 2.2. Summary of mine infilling solution mixing ratios and geochemical conditions under which they were mixed.

Filling Scenario	Solution Mixing[3]	Eh	pCO_2
During Filling[1]	52.2% Wall Rinse 47.8% LF-120 Seep 0.01% ARD (un-neutralized 2875 Seep) (ph 2.3)	100 mV	$10^{-2.5}$ atm
Post Filling[2]	68.6 % Neutralized 2875 Seep 31.4 % LFC-120 Seep	0 mV	$10^{-2.5}$ atm

may used .001% but is wrong

why no increase in oxidation pH

what is % of pyrite and coating %

Notes:

1. *Conditions resulted in worst case water quality during filling* — not true
2. *Sorption surfaces and solids from worst chemistry during filling were used for this case*
3. *Values from inflow rates in updated hydrologic modeling.*

2.3 Impact Evaluation

The Impact Evaluation has been performed in the same manner employed in the RIE. This approach consists of an evaluation of the attenuation of metals in mine water, represented by the results of the geochemical modeling, along the flowpath out of the mine. Laboratory data on the attenuation capacities of the various lithologies adjacent to the mine were used. In the RIE, water flowed along an approximately 1000 foot flowpath through several lithologies, culminating as diffuse flow into Wolfe Camp Creek. To be consistent with the conservative updated hydrologic model, the current evaluation assumes flow only along a 50 foot flowpath in the modeled fault prior to reporting to Wolfe Camp Creek. This is conservative in that a portion of the actual flow will likely occur in bedrock along a much longer flowpath (and thus higher attenuation) to Wolfe Camp Creek. The attenuative properties of the fault area were characterized by assuming a 50:50 blend of clastics and altered limestone, the two lithologies present adjacent to the fault.

Table 2.2. Summary of mine infilling pollution loading ratios and geochemical conditions under which they were noted.

Tailing Filling[1]	52.6% Wet Rock 47.3% 12-100 Sieve 0.07% ARD gen. non-acidic 2525 Sieve	100 mV	10^{-2} atm
Rock Filling[2]	80.2 % Waste rock 2575 Sieve 19.4% 12-100 Sieve	0 mV	10^{-4} atm

Notes:

1. Conditions equivalent to Alice Arm pack, quartz dominant
2. Subject to lower and acidic pore water conditions during mining and leaching in Alice Arm
3. Values from pilot-scale experiment (Morin et al., 1991)

2.3 Impact Evaluation

The Impact Evaluation has been performed in the same manner employed in the 1991 [illegible]. This approach consists of an evaluation of the attenuation of metals in mine water, represented by the results of the geochemical modelling, along the flowpath out of the mine. Laboratory data on the attenuation capacities of the various lithologies adjacent to the mine were used. In this MOE notes flows along an approximately 1000 foot flowpath through several lithologies, culminating as diffuse flow into Wolfe Camp Creek. To be consistent with the conservative approach lithologic model, the current evaluation assumes flow only along a 50 foot flowpath in the modeled tailings pore water entering to Wolfe Camp Creek. This is conservative in that a portion of the actual flow will likely occur in fractures along a much longer flowpath (and thus higher attenuation) to Wolfe Camp Creek. The extension of properties at the fault was more characterized by assuming a 50:50 blend of clastics and altered limestone, the two lithologies present adjacent to the fault.

3.0 Results

3.1 Hydrology

3.1.1 Field Hydrology

The Interim Proposal study involved collection of data from exploration drilling, monitoring, and compilation of a current potentiometric surface map. The results of this study confirm that the current understanding and conceptual hydrologic model of the Lamefoot project area are applicable to the Interim Proposal area and north to the North Lamefoot area. The Interim Proposal area ground water system is a continuous extension of the Lamefoot mine area regime.

In summary, the hydrogeologic characteristics of the Interim Proposal area and Lamefoot mine area are characterized by:

- Very low bulk rockmass hydraulic conductivity ranging from 10^{-7} to 10^{-6} cm/sec;
- Secondary permeability developed along local fracture and fault systems with hydraulic conductivity ranging from 10^{-4} to 10^{-3} cm/sec;
- Low storage and drainable porosity;
- A storage coefficient estimated to be greater than 0.005;
- Effective drainable porosity of 0.0036 percent;
- Near surface potentiometric surface due to low bulk rockmass hydraulic conductivity and low drainable porosity and a limited drawdown cone developed around the mined areas;
- Hydraulic gradient of the regional ground water flows towards the west generally following local topography;

In summary, mining activities have dewatered only a limited area around the mine footprint. This is attributed to the very low permeability of rock surrounding the mine, as evidenced by the extremely small inflow recorded for the mine. Only wells very near the mine workings have been impacted by dewatering. A detailed discussion of the field work, data compilation and results, as well as a history of field hydrologic work at the Lamefoot Mine, is presented in Appendix A.

3.1.2 Hydrology Modeling

The conclusions of the re-modeling of the worst-case effects of the mining associated with the proposed interim expansion at the Lamefoot Project on groundwater flow and heads are as follows:

- The maximum average groundwater inflow to the mine during mining is computed to be 38 gpm, of which approximately 18 gpm would pass through the crown pillar and 20 gpm would enter the mine through the mine walls.

- The maximum average groundwater flow through the mine after closure and refilling is computed to be 25 gpm, of which approximately 17 gpm would pass through the crown pillar, and 8 gpm would enter the mine through the wall rock.

- The maximum area of the crown pillar that could be impacted by permanent post-mining water level reductions in excess of 10 feet is approximately 9.7 acres, conservatively assuming total disturbance of the crown pillar material.

A detailed presentation and discussion of modeling are presented in Appendix B.

3.2 Geochemistry

Results of the before and after filling geochemistry modeling (pore volumes 2 and 10) are summarized in Table 3.2 and are very similar to those obtained during past modeling efforts. Mine water has a slightly alkaline pH and low metal concentrations. Recall that these results represent the geochemical conditions which yielded the worst predicted after filling water quality in the RIE (Case C-Q1, Table 3.4 of Appendix B of RIE). Model output files are presented in Appendix C.

3.3 Impact Evaluation

Results from geochemical modeling presented in Table 3.1 were used to evaluate attenuation of copper and zinc along the flowpath through bedrock adjacent to the mine. Recall that this analysis conservatively assumes that all water from the mine will flow through only the modeled fault along a 50 foot flowpath to Wolfe Camp Creek. Results are presented in table 3.2 and indicate that metals are further attenuated within a very short distance along the flowpath owing to the attenuation capacity of the bedrock and the low concentrations of copper and zinc in the mine water. This is true even for the conservative case where only 0.4 % of the laboratory-measured attenuation capacity is utilized. This is a very conservative value for the relatively high permeability, fractured fault zone represented in the updated hydrologic model. It is important to note that metal concentrations are already low (Cu = 0.002

mg/l, Zn = 0.007 mg/l) in mine water prior to any further attenuation by adjacent bedrock.

Table 3.1. Geochemical modeling output for worst case bounding conditions.

	Parameter	Units	1st Pore Vol.	2nd Pore Vol.	10th Pore Vol.
Input	PCO_2	atm	-2.5	-2.5	-2.5
	Temp	°o	10	10	10
	Eh	mV	100	0	0
Output	Ionic Strength		0.05	0.05	0.04
	pH	s.u.	7.44	7.43	7.43
	Charge Inbal.[3]	%	0	0	0
Majors	Ca	mg/L	298	304	304
	Cl	mg/L	6.11	3.62	3.62
	F	mg/L	0.243	0.110	0.110
	K	mg/L	3.89	3.90	3.90
	Mg	mg/L	228.7	239.0	239.0
	Na	mg/L	65.12	60.3	60.4
	SO_4	mg/L	1768	1704	1702
Metals	Ag	mg/L	0.005	0.008	0.008
	Al	mg/L	0.014	0.014	0.014
	As	mg/L	0.000	0.000	0.000
	Ba	mg/L	0.003	0.003	0.003
	Cd	mg/L	0.000	0.004	0.006
	Cu	mg/L	0.000	0.002	0.008
	Fe	mg/L	0.306	4.550	4.550
	Mn	mg/L	1.114	2.220	2.220
	Ni	mg/L	0.004	0.006	0.021
	Pb	mg/L	0.000	0.000	0.000
	Zn	mg/L	0.003	0.007	0.035
PPP Solids[4]	Gypsum	mg	12949.2	15235	20546
	Barite	mg	0.164	0.329	01.865
	Boehmite	mg	1.251	1.330	2.016
	Ferrihydrite	mg	5370	0	0
	Siderite	mg	0.0	3.7	35.4

Note: Calcite and pyrite present as finite solids; determined from static test results.

Ref:\166\dat\geomodel\remodel98

why conc. increase in 10th P.V.?

mg/l, Zn = 0.007 mg/l) in mine water prior to any further attenuation by adjacent backfill.

Table 3.2. Flowpath attenuating analysis for mine water after filling (Pore Volume 2).

Metal	% Attenuation Allowed	Flow path through 50 feet clastic/altered limestone fault zone	
		Distance Removed[1]	Safety Factor[2]
Copper	0.4	7.4	7
	10	< 1	124
	100	< 1	1240
Zinc	0.4	21	2
	10	< 1	56
	100	< 1	560

1 – Distance removed includes metals attenuated in pore volume 1.

2 – Safety factor is flowpath length divided by distance removed; determined from laboratory adsorption capacity and predicted mine water chemistry in Table X.3. Note concentrations of copper and zinc in mine water are low prior to flowpath attenuation.

4.0 Conclusions

An updated impact evaluation was performed to determine the effects of a proposed interim expansion of operations at the Lamefoot Mine. The evaluation represents a worst case bounding condition for hydrology and geochemistry. Recent hydrologic flow information was incorporated into an updated hydrologic model to determine mine inflow rates. These model inflow values were then used in conjunction with conservative water quality input chemistry in a geochemical model to predict mine water quality. Impacts to water resources adjacent to the mine were predicted by performing a flowpath attenuation analysis using the results of the geochemical modeling.

- Results of the recent field hydrologic work and review of past field efforts confirm previous conclusions and indicate that mining activities have dewatered only a limited area around the mine footprint. This is attributed to the very low permeability of rock surrounding the mine, as evidenced by the extremely small inflow recorded for the mine.

- Hydrologic modeling indicates that even under worst case bounding conditions, long-term steady state inflow values to the mine as a result of the proposed expansion remain low (24.5 gpm).

- Geochemical modeling indicates that post-filling mine water will have a slightly alkaline pH (7.4) and low metal concentrations (copper = 0.002 mg/l, zinc = 0.007 mg/l), which will be further attenuated as water flows through adjacent fault and bedrock material.

The findings corroborate previous modeling efforts and indicate that there will be no impacts to water resources adjacent to the Lamefoot Mine as a result of the proposed interim expansion.

5.0 References

Chronological Listing

2750 Level Hydrology and Hydrogeochemistry Final Report. July 1995. Adrian Brown Consultants, Schafer and Associates, Hydro-Geo Consultants.

Impact Evaluation for Full Development of the Lamefoot Mine. July 1995. Adrian Brown Consultants, Schafer and Associates, Hydro-Geo Consultants.

Hydro-Geo Consultants, Inc., January 1997. North Lamefoot Hydrogeologic Study, Echo Bay Minerals-Kettle River Operations, Lamefoot Mine. Final Report, prepared for Echo Bay Minerals Company.

Revised Impact Evaluation for the Proposed Expansion of the Lamefoot Mine. May 1997. Schafer and Associates, Adrian Brown Consultants.

Technical Memorandum: Response to BLM Comments on the Revised Impact Evaluation for the Lamefoot Mine. October 9, 1997. Schafer and Associates

Technical Memorandum: Response to BLM Comments on the Revised Impact Evaluation for the Lamefoot Mine – Geochemical Model Revisions. October 9, 1997. Schafer and Associates

Hydro-Geo Consultants, Inc., November 1997. Addendum to the North Lamefoot Hydrogeologic Study, Echo Bay Minerals-Kettle River Operations, Lamefoot Mine. Final Report, prepared for Echo Bay Minerals Company.

Letter Correspondence: Lamefoot Mine - Request for mining Upper Zone 2, mining in Zone 4, primary development in Zone 6 and minor ramp construction in Zone 7. February 4, 1998. Echo Bay to BLM – Spokane.

APPENDIX
A

Appendix A

Lamefoot Mine Hydrogeologic Study

Hydro-Geo Consultants, Inc.
March 1998

LAMEFOOT MINE HYDROGEOLOGIC STUDY
INTERIM MINE EXPANSION PROPOSAL
ECHO BAY MINERALS - KETTLE RIVER OPERATIONS
LAMEFOOT MINE
REPUBLIC, WASHINGTON

March 16, 1998

Prepared for: Echo Bay Minerals Co.
921 Fish Hatchery Road
Republic, WA 99166

Prepared by: Hydro-Geo Consultants, Inc.
165 S. Union Blvd., Suite 400
Lakewood, CO 80228

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LAMEFOOT MINE HYDROGEOLOGIC STUDY
INTERIM MINE EXPANSION PROPOSAL
ECHO BAY MINERALS - KETTLE RIVER OPERATIONS
LAMEFOOT MINE
REPUBLIC, WASHINGTON

1.0 INTRODUCTION

Echo Bay Minerals Company (Echo Bay) operates a gold mining and processing operation near the town of Republic, Washington known as the Kettle River Project. The current Kettle River Operation includes the Key Processing facility, the Lamefoot Mine, and the K2 Exploration Project. The Lamefoot Mine was permitted for full development in 1995 (BLM, Record of Decision, Sept., 1995). Full mine development extends from northings 24500 N to 27500 N with a total vertical extent ranging from 3,100 to 2,200 feet above mean sea level (amsl).

Echo Bay has determined that potential economic ore extends north of the permitted mining area to approximately northing 28300. The orebody is known as North Lamefoot. In addition, several pods of ore, extensions of the currently permitted orebody, are located directly north and adjacent to the current mine workings at northing 27500. Echo Bay has proposed to mine these orebody extensions and complete associated access development. Proposed mining of these small ore zones is known as the " Lamefoot Interim Proposal". Full development of the Interim Proposal area would extend from northing 25850 to 28000 with a vertical extent of 3,115 to 1,850 feet amsl. Development of Interim Proposal area would utilize the same mining methods, ore haulage, and processing as the current mining operation.

To support permitting requirements for the Interim Proposal mining area, Echo Bay retained Hydro-Geo Consultants, Inc. (Hydro-Geo) to complete a verification ground water characterization study for the Interim Proposal mining area. The results of this study confirm that the current understanding and conceptual hydrologic model developed for the permitted Lamefoot project area are applicable to the Interim Proposal area.

change of K
TV 10^{-3}

LANEFOOT MINE HYDROGEOLOGIC STUDY
PETERSON MINE EXPANSION PROPOSAL
ECHO BAY MINERALS - KETTLE RIVER OPERATIONS
LANEFOOT MINE
REPUBLIC, WASHINGTON

1.0 INTRODUCTION

Echo Bay Minerals Company (Echo Bay) operates a gold mining and processing operation near the town of Republic, Washington known as the Kettle River Project. The current Kettle River Operation includes the Key Processing facility, the Lanefoot Mine, and the K2 Exploration Project. The Lanefoot Mine was permitted for full development in 1992 (Bill M. Record of Decision, Sept. 1992). Full mine development extends from northings 24500 N to 27500 N with a total vertical extent ranging from 3,100 to 2,270 feet above mean sea level (amsl).

Echo Bay has determined that potential economic ore exists north of the permitted mining area to approximately northing 28500. The orebody is known as North Lanefoot. In addition, several pods of ore, extensions of the currently permitted orebody, are located directly north and adjacent to the current mine workings at northing 27500. Echo Bay has proposed to mine these orebody extensions and complete associated access development. Proposed mining of these small ore zones is known as the "Lanefoot Interim Proposal". Development of the Proposed area would extend from northing 27500 to 28000 with a vertical extent of 2,145 to 2,530 feet amsl. Development of Interim Proposal area would utilize the same mining methods, ore haulage, and processing as the current mining operation.

To support permitting requirements for the Interim Proposal mining area, Echo Bay retained Hydro-Geo Consultants, Inc. (Hydro-Geo) to complete a ventilation ground water characterization study for the Interim Proposal mining area. Descriptions of this study are in the current groundwater and associated hydrologic model developed for the permitted mine plan, as applicable to the Interim Proposal area.

2.0 PREVIOUS WORK

Echo Bay has been operating the Kettle River Project since 1988. Permitting for this facility was completed following the preparation of a Final Environmental Impact Statement or FEIS (State of Washington, Dept. of Ecology, 1988). The original mine plan was based on two underground mines, the Kettle River and Overlook mines, and a common process facility, the Key Mill.

With the discovery of the Lamefoot orebody, the Key Project FEIS was formally amended in 1994 with an Environmental Impact Statement Supplement or EISS (USBLM, 1994a) to the 1992 FEIS which specifically addresses the impacts due to inclusion of the Lamefoot Mine in the overall mine plan. In compliance with permitting provisions, Echo Bay has also submitted a revised Plan of Operations (Echo Bay, 1993) for its facilities to include the Lamefoot Mine.

In the Proposed Action for the Lamefoot Mine as presented in the EISS, mining would extend to the anticipated extent of ore reserves at an elevation of about 2,200 feet amsl. An alternative plan adopted by the U.S. Bureau of Land Management (BLM) was presented as the Preferred Alternative in the Record of Decision (USBLM, 1994b). This alternative was identical to the Proposed Action but limited mining to the 2,750 level elevation which was the estimated post-closure water table elevation.

Echo Bay believed that the Proposed Action was an environmentally sound approach to the development of the Lamefoot mine and requested that the BLM review its original rulings released in the Record of Decision (ROD) (USBLM, 1994b). To support its request Echo Bay undertook a program of investigation and evaluation consistent with BLM's request to "...further characterize the groundwater conditions at the (Lamefoot Mine) site, ... to refine predictions (of) possible hydrologic impacts, ... in order to have the additional data necessary to reconsider the cumulative impacts of the full mine development" (USBLM, 1994b).

The results of the investigation program were published in a document known as the 2750 Report (Adrian Brown Consultants, Hydro-Geo Consultants, and Schafer and Associates, 1995). This comprehensive ground water investigation program included geologic characterization, numerous well and test hole installations, more than 90 permeability tests, and continuous ground water sampling and water level measurements. The major conclusions of the study were:

- the water table in the vicinity of the mine is considerably above the 2,750 foot elevation and in fact is close to (<50 feet), or at, the ground surface;

For calc. of K for rockmass see 2750 rept pg 25, App. A

- the various lithologies within and surrounding the mine have very low permeability with hydraulic conductivities ranging from approximately 1.6 x 10^{-6} to 2.5 x 10^{-7} cm/sec.;

contrary to what's in 2750 rept.

- most ground water flow within the area is governed by the existence of faults and fractured zones;

wrong - did ventilation test so flow was 250gpm

- the total direct, measurable inflow to the mine in December, 1994 was approximately 1 gpm (excluding induced water for drilling and other mine use), and; misleading use range

from 2750 rept pg. 5-2

- there will be no significant ground water or surface water impact resulting from the development of the Lamefoot mine. This will be true regardless of the depth of development of the mine and there will be no incremental ground water impact associated with full development of the mine as compared with development limited to the 2,750 foot elevation. keep within value of data

Subsequent to the 2750 study, Hydro-Geo completed two reports on the hydrogeology of the North Lamefoot Expansion area. The first report, North Lamefoot Hydrogeologic Study (Hydro-Geo, January 1997), involved collection of data from exploration drilling, drilling and testing of two monitoring wells, completion of a spring and seep survey, observations during development of the North Lamefoot exploration drift (2420 level drift), and review of information from past studies and monitoring wells associated with the existing Lamefoot mine area.

The results of this study confirmed that the current understanding and conceptual hydrologic model of the Lamefoot project area are applicable to the North Lamefoot area. The North Lamefoot area ground water is a continuous extension of the Lamefoot mine area regime and includes:

- Very low bulk rockmass hydraulic conductivity ranging from 10^{-7} to 10^{-6} cm/sec; est. from mine inflows
- Secondary permeability developed along local fracture systems with hydraulic conductivity ranging from 10^{-4} to 10^{-3} cm/sec;
- Low storage and drainable porosity;
- Near surface potentiometric surface due to low bulk rockmass hydraulic conductivity and low drainable porosity;
- A storage coefficient estimated to be greater than 0.005;
- Effective drainable porosity of 0.0036 percent; from 2750 rept - pg. 2-12 est. calc. by using mine inflows
- Bulk hydraulic conductivity ranging between 2 x 10^{-7} and 2 x 10^{-6} cm/sec with localized increases due to fracturing and/or faulting;
- Hydraulic gradient of the ground water flows towards the west generally following local topography; and,

- the various lithologies within and surrounding the mine have very low permeability with hydraulic conductivities ranging from approximately 1.6 x 10^{-6} to 2.5 x 10^{-7} cm/sec;
- most ground water flow within the area is governed by the existence of faults and fractured zones;
- the total direct, measurable inflow to the mine in December, 1994 was approximately 1 gpm (excluding indirect water for drilling and other mine use), and;
- there will be no significant ground water or surface water impact resultant from the development of the Lamefoot zone. This will be true regardless of the depth of development of the mine and there will be no incremental ground water impact associated with full development of the mine as compared with development limited to the 2,750 foot elevation.

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- Very low bulk mechanics hydraulic conductivity ranging from 10^{-7} to 10^{-6} cm/sec;
- Secondary permeability developed along local fracture systems with hydraulic conductivity ranging from 10^{-6} to 10^{-4} cm/sec;
- Low storage and drainable porosity;
- Near surface potentiometric surface due to low bulk mechanics hydraulic conductivity and low drainable porosity;
- A storage coefficient estimated to be greater than 0.005;
- Effective drainable porosity of 0.0036 percent;
- Bulk hydraulic conductivity ranging between 2 x 10^{-7} and 2 x 10^{-6} cm/sec with increased increases due to fracturing and/or faulting;
- Hydraulic gradient of the ground water flows towards the west generally following local topography; and,

- There is no significant difference between the ~~in~~ ground water quality in the Lamefoot North area and other areas on the mine site, what about WQ? although Antimony has been noted

This low hydraulic conductivity of the bedrock limits the ground water flow in the area as evidenced from the extremely small inflow recorded for the mine. Except for high flow in spring

The second report, "Addendum to the North Lamefoot Hydrogeologic Study" (Hydro-Geo, November, 1997), was prepared to address comments by the BLM regarding the original North Lamefoot Hydrogeologic Study (Hydro-Geo, January, 1997), memo from Mr. Paul Summers to Mr. George Brown dated July 11, 1997.

In order to address these concerns, a new potentiometric surface map was prepared which incorporated recent water level measurements from monitoring wells and water production wells throughout the Lamefoot mine area, including North Lamefoot. In addition, five underground boreholes in the 2225 exploration drift were tested (pressure buildup and discharge tests) to determine the hydraulic characteristics of the fractured rock associated with the Wolf Camp Fault zone in the northern area of the North Lamefoot deposit (28100 to 28300 north). The text of the addendum discussed the most current concept of the mining plan for the North Lamefoot orebody and relates it to the hydrogeologic characterization of the Lamefoot Mine area, as determined from the 2750 Level Hydrology and Hydrogeochemistry Report (Adrian Brown Consultants, Hydro-Geo Consultants, Inc., and Schafer and Associates, 1995) and from the North Lamefoot Hydrogeologic Study (Hydro-Geo Consultants, Inc., 1997). In addition, the text of the addendum was revised to include updated survey information regarding the surface and ground water level elevations for wells LF-13 and LF-14.

Results from the addendum study were consistent with past studies with an estimated overall hydraulic conductivity of the rockmass in the Lamefoot mine area of 1×10^{-6} cm/sec. The pressure buildup and discharge tests in the Wolf Camp Fault zone indicate an average hydraulic conductivity of 6.33×10^{-4} cm/sec, confirming past estimates ranging from 1×10^{-4} to 1×10^{-3} cm/sec (Hydro-Geo, January 1997). The regional ground water flow is from east to west.

Issue is flows > 2750 rept.
compare it to 2750 rept.

3.0 SCOPE OF WORK FOR THE CURRENT STUDY

A scope of work was developed and undertaken to address the concerns of the BLM regarding development of the Lamefoot Interim Proposal area. The scope of work for the project was discussed during a meeting on March 3, 1996 between members of the BLM, Echo Bay, Mr. Joe Frank, Hydro-Geo Consultants, Inc., Adrian Brown, Adrian Brown Consultants, Inc., and Ed

Spotts, Schafer and Associates, Inc. The current scope of work includes:

- A review of the geologic cross sections and drillers reports developed from data collected from exploration drilling along the 2225 drift. This information will be used as a basis to relate ground water occurrence to geologic structures at the Lamefoot site including the North Lamefoot area;
- Compilation and review of water level data from area wells and surface water monitoring sites. This information will be used to assess current impacts of mining to the area hydrologic system, and;
- Complete a detailed potentiometric surface map using current water level data and estimated drawdown near the mine development areas.

4.0 GROUND WATER CHARACTERIZATION PROGRAM

The purpose of the ground water characterization program is to provide further hydrogeological characterization of the Lamefoot Interim Proposal area. The following section of the report presents hydrogeologic information gathered as part of this investigation to further characterize the ground water system in the vicinity of the Lamefoot Interim Proposal area.

4.1 Cross Section Analysis

Thirteen geologic cross sections and associated drillers logs, provided by Echo Bay, were analyzed to determine the relationship between ground water occurrence and geologic structure. The cross sections were developed by Echo Bay's geology department from corehole data collected during exploration drilling along the 2225 level drift. Ground water occurrences were taken from daily drillers logs recorded during drilling operations. The following cross sections and associated drillers logs were reviewed:

- 27150 north
- 27300 north
- 27400 north
- 27500 north 27760 missing
- 27700 north
- 27800 north
- 27900 north

Spoits, Schafer and Associates, Inc. The current scope of work includes:

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4.1 Cross Section Analysis

Thirteen geologic cross sections and associated drillers logs, provided by Echo Bay, were analyzed to determine the relationship between ground water occurrence and geologic structure. The cross sections were developed by Echo Bay's geology department from conduite data collected during exploration drilling along the 2225 level drift. Ground water occurrences were taken from many drillers logs recorded during drilling operations. The following cross sections and associated drillers logs were reviewed:

- 27150 north
- 27300 north
- 27400 north
- 27500 north
- 27700 north
- 27800 north
- 27900 north

- 28000 north
- 28100 north
- 28200 north
- 28300 north

Copies of the cross sections and drillers logs are included in the Appendix A. Cross section locations are illustrated on Figure 1.

4.1.1 Conclusions

27 600 crossed fault trickle at fault

Ground water was not encountered in areas near the current mining operations. Review of drillers logs from cross sections 27150 and 27500 north indicated dry conditions during drilling operations. This supports observations at the mine of very limited ground water inflow in this area. At cross section 27700 north, small flows of ground water were recorded in boreholes 27700-2, 3, and 4. In each case flows were noted at or east of the Anfo Fault contact. Flow increased from 0.5 gpm to 3.0 gpm as absolute elevation decreased reflecting an increasing head along the structure. It is important to note that the boreholes were reported dry up to the Anfo Fault contact.

Small flows adjacent to and east of the Anfo Fault continue north to sections 27800 and 27900 increasing slightly from 1.5 to 10 gpm. Again flows increased with depth (lower elevation), reflecting normal head changes. In addition, minor flows were also recorded west of the Anfo Fault at or near intrusive contacts. In borehole 27800-2 a flow of 3 gpm was recorded at a depth of 170 feet at or near an intrusive limestone contact. A flow of 1 gpm was noted in borehole 27900-1 near a similar contact.

At section 28000 north a flow of 1.5 gpm was recorded along the Wolf Camp Fault in borehole 28000-1. This is the first recorded flow along this structure. Again small flows ranging from 1 to 3 gpm were noted at or east of the Anfo Fault at this section location.

Moving north to section 28100 north, flows generally increased east and west of the Anfo Fault. Flows of 12 gpm were recorded in borehole 28100-2 at a depth of 518 feet, east of the Anfo Fault. Flows of 15 gpm were noted in borehole 28100-5 just west of the Anfo Fault. Flows of 12 to 15 gpm were recorded in boreholes 28100- 3 and 6 in the zone between the Wolf Camp and Anfo Faults, possibly related to intrusive contacts. No flows were noted along the Wolf Camp Fault at this location.

At section 28200 north only one borehole penetrated the Anfo Fault, 28200-5. A small flow of 1 to 2 gpm was noted east of the fault. Two boreholes encountered water along the Wolf

Copies of the cross sections and drillers logs are included in the Appendix A. Cross section locations are illustrated on Figure 1.

4.1.1 Conclusions

Ground water was not encountered at least near the current mining operations. Review of drillers logs from cross sections 27150 and 27500 north indicated dry conditions during drilling operations. This supports observations at the mine of very limited ground water inflow in this area. At cross section 27700 north, small flows of ground water were recorded in boreholes 27700-2, 3, and 4. In each case flows were noted at or east of the Anfo Fault contact. Flow increased from 0.5 gpm to 3.0 gpm as absolute elevation decreased reflecting an increasing head along the structure. It is important to note that the boreholes were reported dry up to the Anfo Fault contact.

Small flows adjacent to and east of the Anfo Fault continue north to sections 27800 and 27900 increasing slightly from 1.5 to 10 gpm. Again flows increased with depth (lower elevation), reflecting normal head changes. In addition, minor flows were also recorded west of the Anfo Fault at or near intrusive contacts. In borehole 27800-2 a flow of 3 gpm was recorded at a depth of 170 feet at or near an intrusive limestone contact. A flow of 1 gpm was noted in borehole 27900-1 near a similar contact.

At section 28000 north a flow of 1.5 gpm was recorded along the Wolf Camp Fault in borehole 28000-1. This is the first recorded flow along this structure. Again small flows ranging from 1 to 3 gpm were noted at or east of the Anfo Fault at this section location.

Moving north to section 28100 north, flows generally increased east and west of the Anfo Fault. Flows of 12 gpm were recorded in borehole 28100-2 at a depth of 518 feet, east of the Anfo Fault. Flows of 15 gpm were noted in borehole 28100-5 just west of the Anfo Fault. Flows of 12 to 15 gpm were recorded in boreholes 28100-3 and 6 in the zone between the Wolf Camp and Anfo Faults, possibly related to intrusive contacts. No flows were noted along the Wolf Camp Fault at this location.

At section 28200 north only one borehole penetrated the Anfo Fault, 28200-5. A small flow of 1 to 2 gpm was noted east of the fault. Two boreholes encountered water along the Wolf

Camp Fault, 28200-1 and 2. A small inflow (rate not recorded) was noted at 230 feet, just east of the Wolf Camp Fault in boring 28200-1. A flow of 20 gpm was noted in borehole 28200-1, just east of the fault. It should be noted that 28200-2 is at a much lower elevation that 28200-1 which probably accounts for the flow differences.

Four boreholes from section 28300 reported groundwater. Drillers reported water (but no flow rate) at 70 feet in borehole 28300-1, and at 80 feet in boreholes 28300-2 and 28300-3. These occurrences are in clastic rock west of the Wolf Camp Fault. In borehole 28300-5 flows of 4 gpm were noted immediately west of the Anfo Fault at a depth of 250 feet.

As part of the "Addendum to the North Lamefoot Hydrogeologic Study" (Hydro-Geo, November 1997) five underground boreholes from the 28100, 28200, and 28300 north areas of the exploration drift were tested. These borings included 28100-1, 28100-3, 28200-1, 28300-2, and 28300-3. After shutting in these holes with packers, hydrostatic pressures built up to between 41 to 49 psi. Once pressures stabilized the valves were opened and initial flows of 43 to 50 gpm were recorded. In less than 2 hours flows decreased to between .063 to 4 gpm indicating limited storage and recharge potential to intercepted fractured systems.

vult. by 14.5
710 ft

Test line in late oct.

In summary, it appears that the structures in the southern portion of the study area have been drained by current mine development. No flows were noted south of section 27700 north. The major portion of the Interim Proposal area lies within this drained portion of the project area. New development in the area should encounter very little if any ground water inflow. From section 27700 to 28000 north, ground water occurrence is noted primarily east of the Anfo Fault with minor amounts reported along intrusive contacts. Initial flows of 0.5 to 6 gpm are noted in this area. One vertically down oriented borehole, 27800-3, reported flows of 10 to 20 gpm at the end of drilling, in the Anfo Fault. However, the final elevation is at this point is approximately 1,625 feet, well below any planned mining level. The occurrence of ground water in the Wolf Camp Fault was noted only along sections 28000, 28200, and possibly 28300 north.

Should be 27600 North

The cross section analysis indicates that fractured zones east and west of the Anfo Fault are water bearing and appear to be continuous north to south. The eastern zone is more prevalent to the south and the western zone is noted to the north of 28100 north. Minor water bearing zones were noted at intrusive contacts throughout the study area. Discontinuous saturated zones were also noted adjacent to the Wolf Camp Fault zone in the farthest north areas of the study. Observations during past and current mining activities support these observations where minor inflows issue from small open fractures along area faults and at intrusive contacts. These intercepts drain quickly indicating limited storage and recharge potential.

4.2 Monitoring Data Review

Echo Bay has monitored numerous surface and ground water stations around the Lamefoot site since 1991. Surface water sites include wetland stations 1 through 4 and the Wolf Camp Spring. Ground water sites include monitoring wells LF-1, LF-2, LF-4, LF-5, LF-6, LF-7, LF-8, LF-10, LF-10T, LF-11, LF-11T, LF-12, LF-13, and LF-14. Summary graphs of the water level and flow data are in Appendix B and locations are shown on Figure 1.

4.2.1 Conclusions

In general the surface stations show strong seasonal changes throughout the period of record with high water levels and flows in the spring and summer months followed be very low levels or dry conditions during the fall and winter. Recent measurements of wetland stations 3 and 4 have not been recorded due to access problems. There has been no apparent decreasing trend of water levels or flows at these sites throughout the period of mining. Haven't recorded for 1 1/2 yrs.

In general ground water elevations in the monitoring wells have also remained steady with some seasonal fluctuations throughout the period of record. Well LF-14 has shown decreasing water level trends. The water level in well LF-14 dropped in September 1997 from about elevation 2,670 feet to 2,136 feet amsl in February 1998. This appears to be attributed to dewatering of fractures intercepted by exploration drilling activities from the 2225 level exploration drift. It should be noted that well LF-13 has continued to recharge since completion in October 1996. Also, well LF-10 recharged from March 1995 to March 1997 from elevation 2,500 feet to over 2,900 feet amsl. Water levels have stabilized since March 1997.

In summary, mining activities have dewatered only a limited area around the mine footprint. This is attributed to the very low permeable rock surrounding the mine. Only wells very near the mine workings have been impacted by dewatering.

LF3 & 13 are below fault

LF-3 vs. 14

LF-3 is artesian - why?

4.3 Potentiometric Surface

A detailed potentiometric surface map of the ground water was compiled using water level data from March 1998 and August 1997 (at limited access areas) along with an estimated dewatered area associated with the current mine workings. Depth to water measurements and associated water level elevations are summarized in Table 1.

4.3.1 Conclusions

Ground water elevations in the Lamefoot area range from 3,234 feet amsl at LF-11 to 2,138 feet amsl at LF-14. The direction of ground water flow in the vicinity of the mine is generally from east to west and closely follows local topography with a sharp drawdown cone immediately surrounding the active mine workings (Figure 1). In general, the ground water gradient is steep in the vicinity of the Lamefoot Mine and decreases to the west towards Curlew Lake.

The ground water elevation at monitoring well LF-14 is particularly low (2,139 feet amsl) and reflects dewatering from exploration drilling at the northern most areas of the 2225 exploration drift. The actual drift elevation in this area (28300N) is approximately 2,096 feet amsl. Fractures intercepted by the drilling operations quickly dewatered with initial flows of about 50 gpm decreasing to flows of less than 5 gpm in about 2 hours.

In summary, the current workings of the Lamefoot mine intercept ground water flow from the east and to some degree from the west and immediately beneath the mine. This creates a radial flow pattern (drawdown cone) near the mine void. Ground water levels in wells adjacent to the mine have not been impacted by dewatering, indicating that the extent of the drawdown cone created by the mine is very limited.

The Lamefoot orebody follows the Anfo Fault structural trend. Water bearing fractured rock adjacent to the Anfo Fault has been locally dewatered by mining activities. However, it is important to note that total water inflows to the mine have remained very small.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

need to explain discrep. betw 2750 not and this.

The Interim Proposal study involved collection of data from exploration drilling, monitoring, and compilation of a current potentiometric surface map.

The results of this study confirm that the current understanding and conceptual hydrologic model of the Lamefoot project area are applicable to the Interim Proposal area and north to the North Lamefoot area. The Interim Proposal area ground water system is a continuous extension of the Lamefoot mine area regime.

The hydrogeologic characteristics of the Interim Proposal area and Lamefoot mine area are characterized by:

- Very low bulk rockmass hydraulic conductivity ranging from 10^{-7} to 10^{-6} cm/sec;
- Secondary permeability developed along local fracture systems with hydraulic conductivity ranging from 10^{-4} to 10^{-3} cm/sec;
- Low storage and drainable porosity;
- Near surface potentiometric surface due to low bulk rockmass hydraulic conductivity and low drainable porosity and a limited drawdown cone developed around the mined areas;
- A storage coefficient estimated to be greater than 0.005; deleted in new version
- Effective drainable porosity of 0.0036 percent;
- An average bulk hydraulic conductivity of about 1 x 10^{-6} cm/sec with localized increases due to fracturing and/or faulting, and;
- Hydraulic gradient of the regional ground water flows towards the west generally following local topography; and,

This low bulk hydraulic conductivity of the bedrock limits the ground water flow in the area as evidenced from the extremely small inflow recorded for the mine.

5.6 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The Interim Proposal study involved collection of data from exploration drilling, monitoring, and compilation of a current potentiometric surface map.

The results of this study confirm that the current understanding and conceptual hydrologic model of the Lamefoot project area are applicable to the Interim Proposal area and known to the North Lamefoot area. The Interim Proposal area ground water system is a continuous extension of the Lamefoot mine area regime.

The hydrogeologic characteristics of the Interim Proposal area and Lamefoot mine area are characterized by:

- Very low bulk rockmass hydraulic conductivity ranging from 10^{-7} to 10^{-8} cm/sec;
- Secondary permeability developed along local fracture systems with hydraulic conductivity ranges from 10^{-6} to 10^{-7} cm/sec;
- Low storage and drainable porosity;
- Near surface potentiometric surface due to low bulk rockmass hydraulic conductivity and low drainable porosity and a limited drawdown cone developed around the tained areas;
- A storage coefficient estimated to be greater than 0.0005;
- Effective drainable porosity of 0.0036 percent;
- An average bulk hydraulic conductivity of about 1 x 10^{-6} cm/sec with localized increases due to fracturing and/or faulting; and,
- Hydraulic gradient of the regional graded water flows towards the west generally following local topography; and,

This low bulk hydraulic conductivity of the bedrock limits the ground water flow in the area as evidenced from the extremely small inflow recorded for the mine.

5.2 Recommendations

It is recommended that Echo Bay continue to collect baseline ground water data for the North Lamefoot area. Baseline data will provide information on water chemistry and seasonal ground water level variations. Monthly laboratory samples should be collected from all area monitoring wells, surface stations, and from the springs located on the Wardlaw property. It should be noted that wetland stations 3 and 4 should be repaired so that water level measurements can be easily collected. The laboratory analytical suite should be the same as the currently permitted suite using total metals values. Field water quality sampling and water level or flow measurements should be collected monthly. It is also recommended that several additional ground water monitoring points be installed west of the ~~proposed~~ ~~North~~ Lamefoot ~~orebody.~~ mine area Locations of these stations should be selected after additional data review and discussions with regulatory agency personnel. In addition, water inflows from underground drilling and development should be recorded regularly.

* * * * *

March 16, 1998

Joe Frank
Senior Hydrogeologist/Project Manager

* * * * *

March 16, 1995

Joe Franc
Senior Hydrogeologist/Project Manager

REFERENCES

Adrian Brown Consultants, Inc., Hydro-Geo Consultants, Inc., and Schafer and Associates, 1995. 2750 Level Hydrology and Hydrogeochemistry, Final Report, prepared for Echo Bay Minerals Company.

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U. S. Department of the Interior, Bureau of Land Management, 1994b, Record of Decision, Lamefoot Mine, Environmental Impact Statement Supplement to the Kettle River Key Project Expansion, November.

TABLES

Table 1
Echo Bay Minerals - Kettle River Operations - Lamefoot Mine
Summary Information of Ground Water Monitoring Wells

Well I.D.	Northing (ft.)	Easting (ft.)	Collar Elevation (ft. amsl)	Screened Interval (ft. btoc)	Depth of Well (ft. btoc)	Depth to Water (ft. btoc)	Elevation of Water in Well (ft. amsl)	Date Measured	Comments
LF-1	24899	5506	2541	10-25	25	8.46	2532.54	3/10/98	
LF-2	26303	6446	2665	21-36	36	23.35	2641.65	3/10/98	
LF-3	28079	7069	2842	510-530	530	TOC	2842	3/10/98	Frozen
LF-4	26298	6439	2662	318-338	340	18.69	2643.31	3/10/98	
LF-5	24460	5152	2520	5-15	18	11.9	2508.1	3/10/98	
LF-6	24383	4908	2518	201-221	223	34.97	2483.03	3/10/98	
LF-7	24385	4916	2518	44-54	54	52.63	2465.37	3/10/98	
LF-8	23673	4845	2508	48-58	58	47.57	2460.43	3/10/98	
LF-10	27480	7283	2975	620-720	720	47.61	2927.39	8/12/97	No Access
LF-10T	27462	7288	2973	7-20	20	15.94	2957.06	8/12/97	No Access
LF-11	25665	7729	3234	625-650	650	TOC	3234	8/12/97	No Access
LF-11T	25649	7758	3234	25-38	38	19.11	3214.89	8/12/97	No Access
LF-13	28388	6749	2833	1055-1105	1105	140.78	2692.22	3/5/98	
LF-14	27874	6281	2920.4	1170-1220	1220	782.01	2138.39	3/5/98	
Wolf Camp Spring	25190	5965	2590	n.a.	n.a.	n.a.	n.a.	3/5/98	

amsl = above mean sea level
btoc = below top of casing
TOC = top of casing

Hydro-Geo Consultants, Inc.

Table 1

Idaho Hay & Minerals - Xerox Lease Operations - Lemhi Pass
Summary Information of Closed Water Monitoring Wells

Well I.D.	Monitoring (yr)	Casing (ft)	Collar Elevation (ft msl)	Screened Interval (ft bloc)	Depth of Well (ft bmp)	Depth to Water (ft bmp)	Elevation of Water in Well (ft msl)	Date Measured	Comments
LF-1	2000	35.0	7541	10-25	25	8.85	7532.54	3/10/98	
LF-2	2000	60.0	7565	21-36	36	23.35	7541.65	3/10/98	
LF-3	2000	106.0	7542	310-330	330	100'	7842	3/10/98	Erosion
LF-4	2000	50.0	7602	375-385	390	18.00	7583.17	3/10/98	
LF-5	2000	51.0	7520	4-15	15	11.4	7508.1	3/10/98	
LF-6	2000	60.0	7518	201-221	225	34.57	7483.05	3/10/98	
LF-7	2000	46.0	7518	44-54	54	54.00	7465.57	3/10/98	
LF-8	2000	46.0	7508	46-56	56	57.57	7500.43	3/10/98	
LF-10	2000	70.0	7515	420-730	730	47.01	7468.99	3/12/97	No Access
LF-101	2000	70.0	7528	7-30	30	13.34	7515.66	3/12/97	No Access
LF-11	2000	77.5	7534	655-850	850	100'	7434	3/12/97	No Access
LF-111	2000	77.5	7534	2-38	38	19.11	7514.89	3/12/97	No Access
LF-12	2000	67.0	7510	1035-1105	1105	140.76	7369.24	3/12/98	
LF-13	2000	65.0	7577.4	1120-1220	1220	78.31	7518.59	3/12/98	
Well Casing Survey	2000	39.65	7590	n.a.	n.a.	n.a.	n.a.	n.a./98	

msl = above mean sea level
bloc = below top of casing
TOC = top of casing

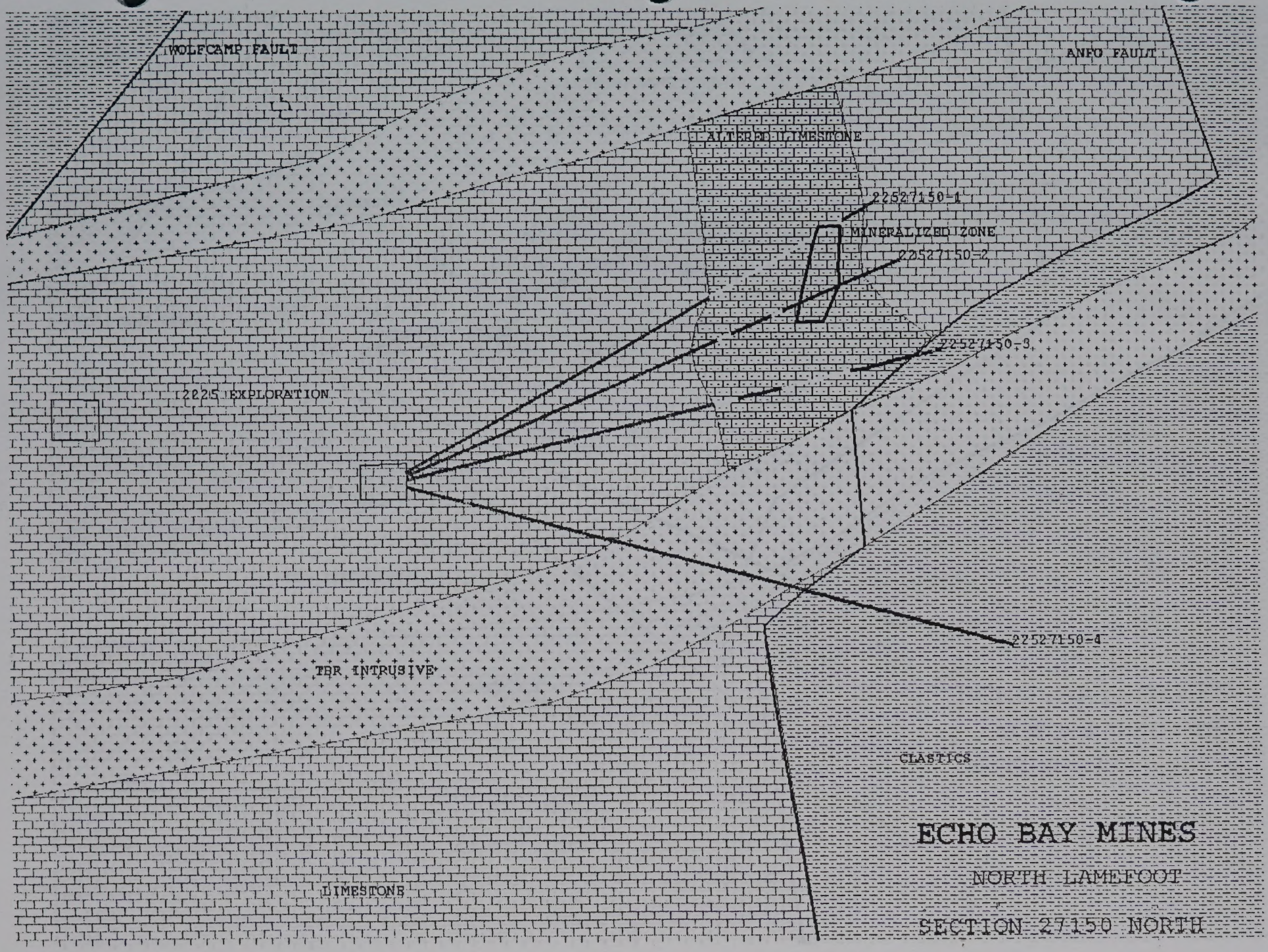
Hydro-Geo Consultants, Inc.

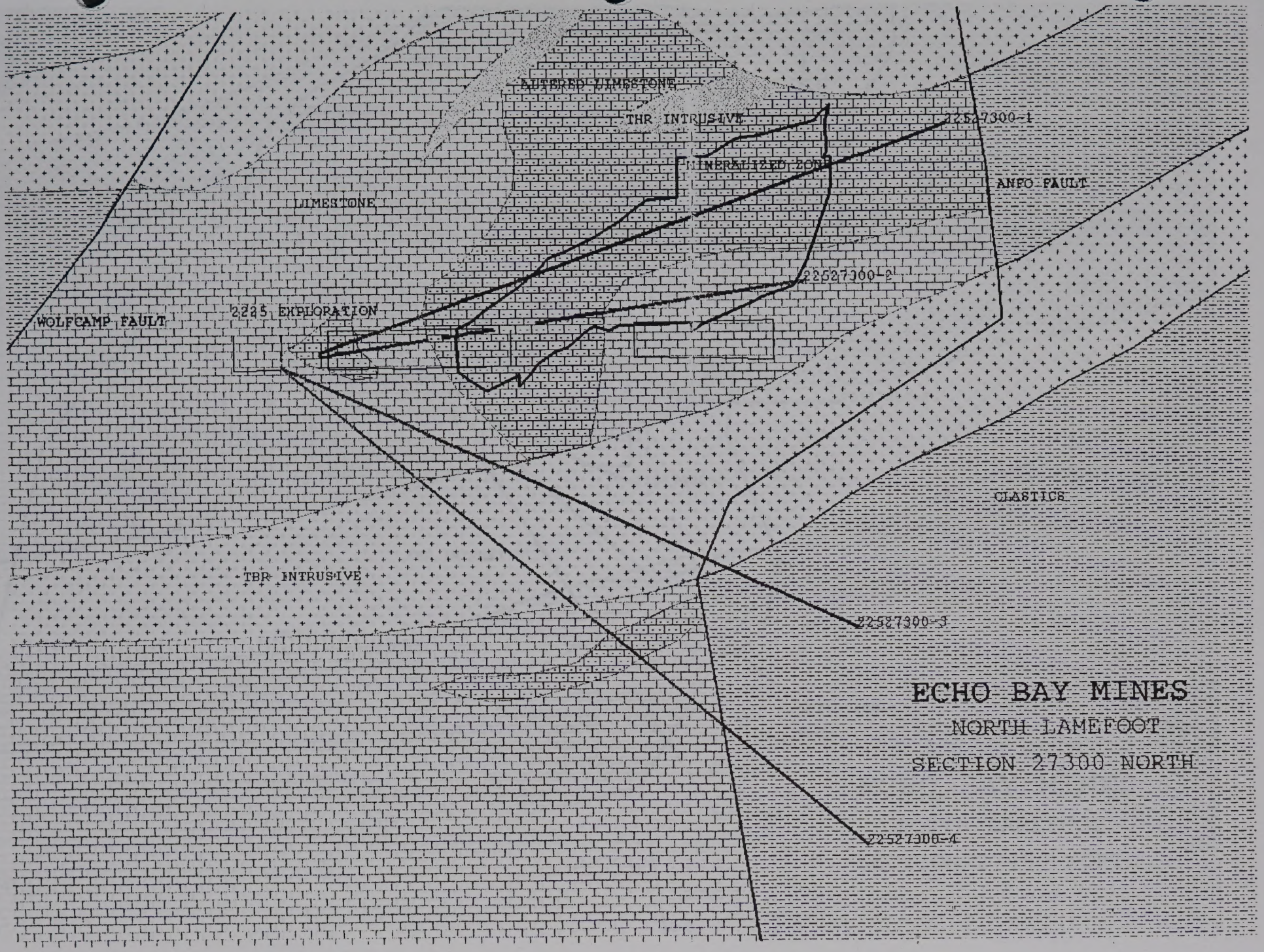
FIGURES

C-LINE #62028
NON-GLARE TOPPER

APPENDIX A

CROSS SECTIONS AND DRILLERS LOGS


WOLFCAMP FAULT
ANFO FAULT
ALTERED LIMESTONE
22527150-1
MINERALIZED ZONE
22527150-2
22527150-3
2225 EXPLORATION
22527150-4
TBR INTRUSIVE
CLASTICS
LIMESTONE
ECHO BAY MINES
NORTH LAMEFOOT
SECTION 27150 NORTH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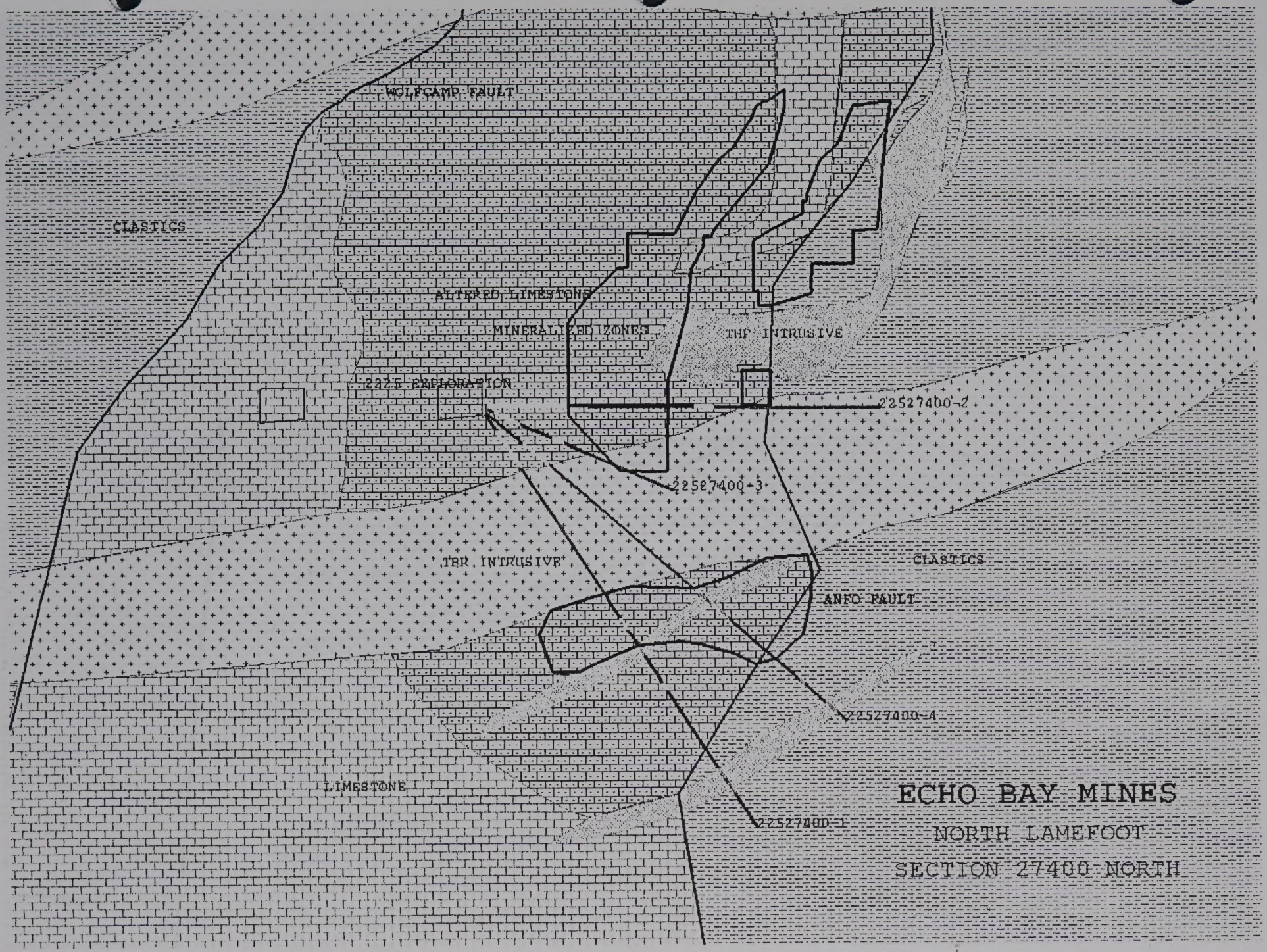
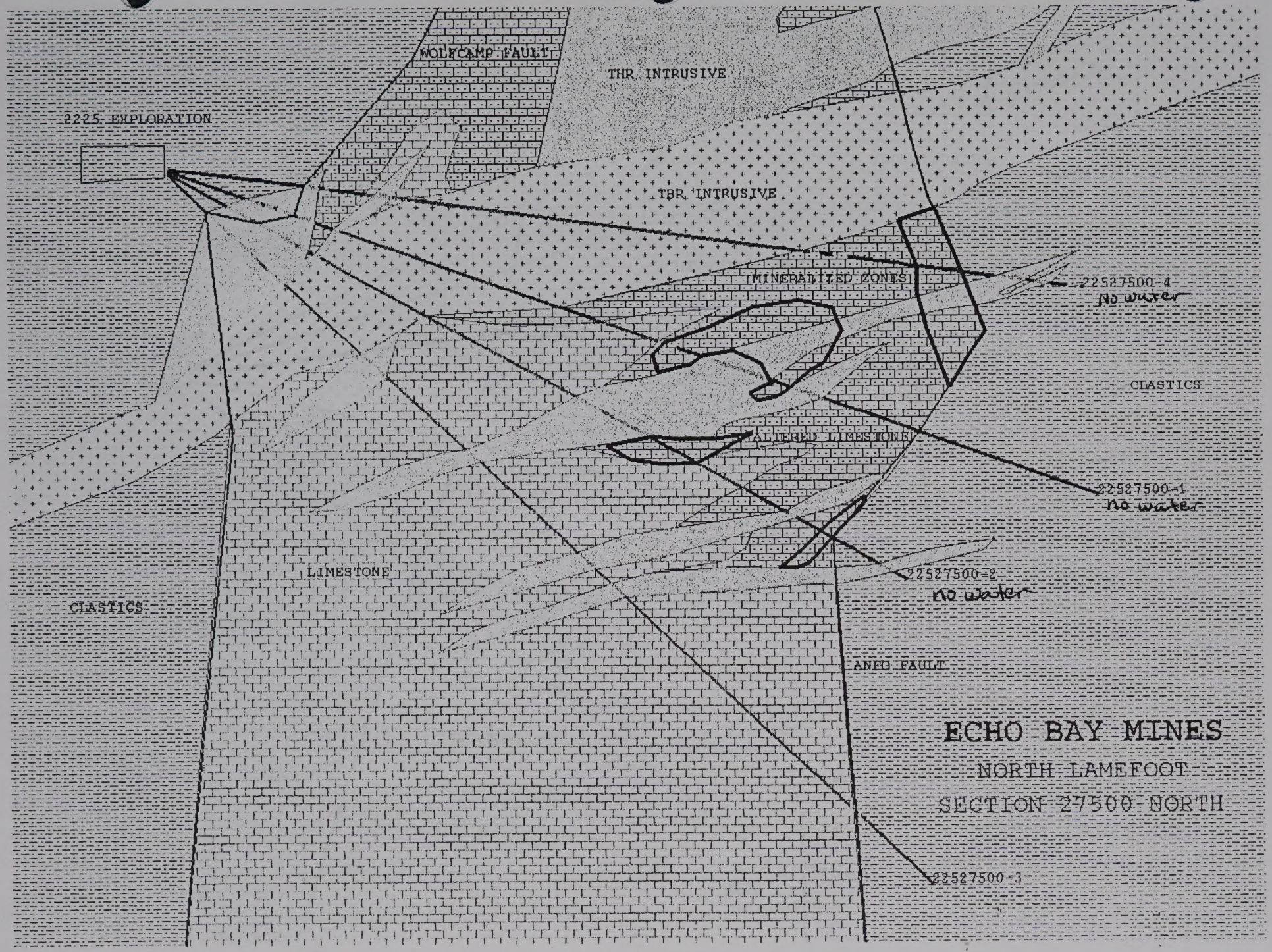
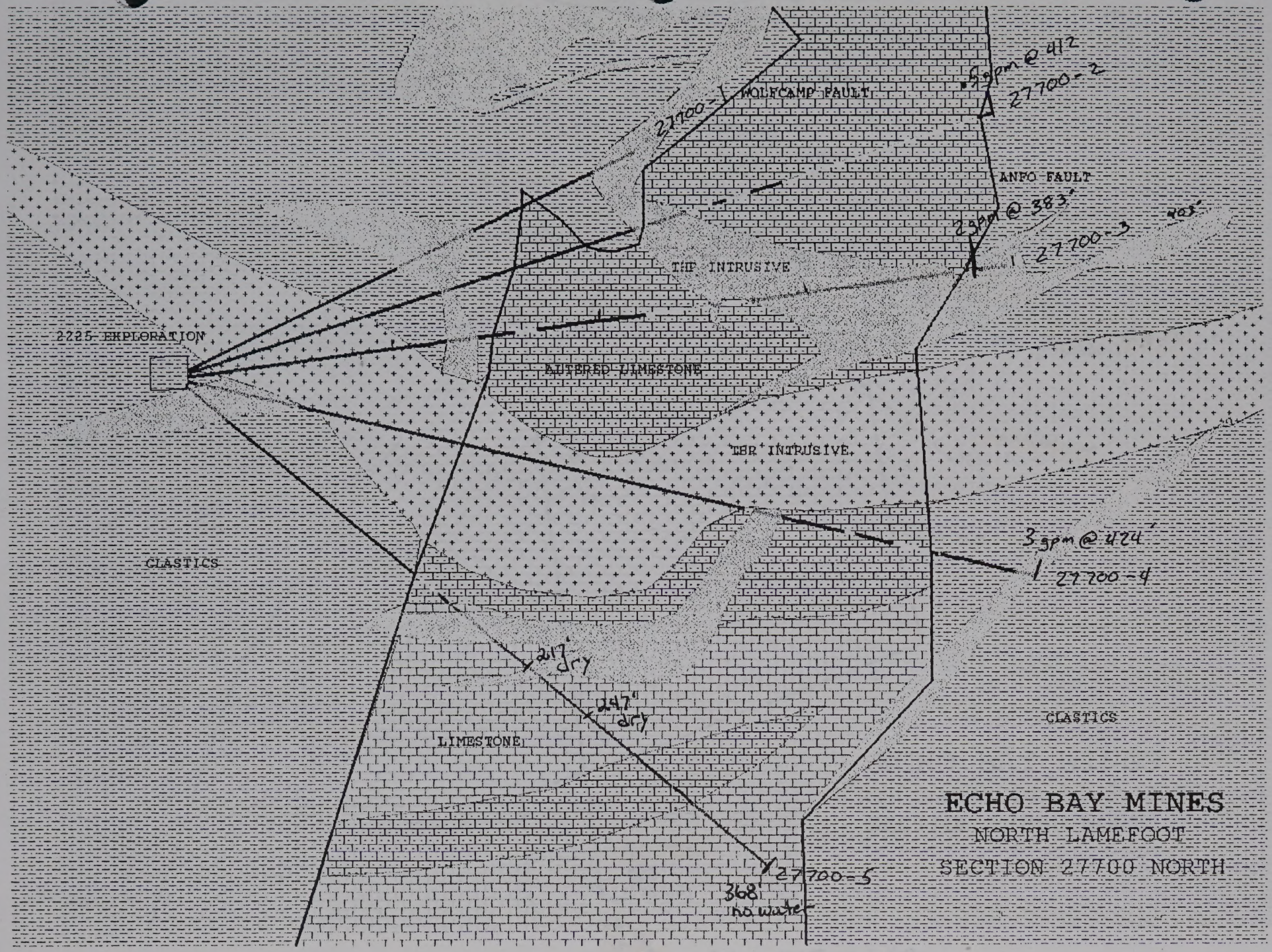
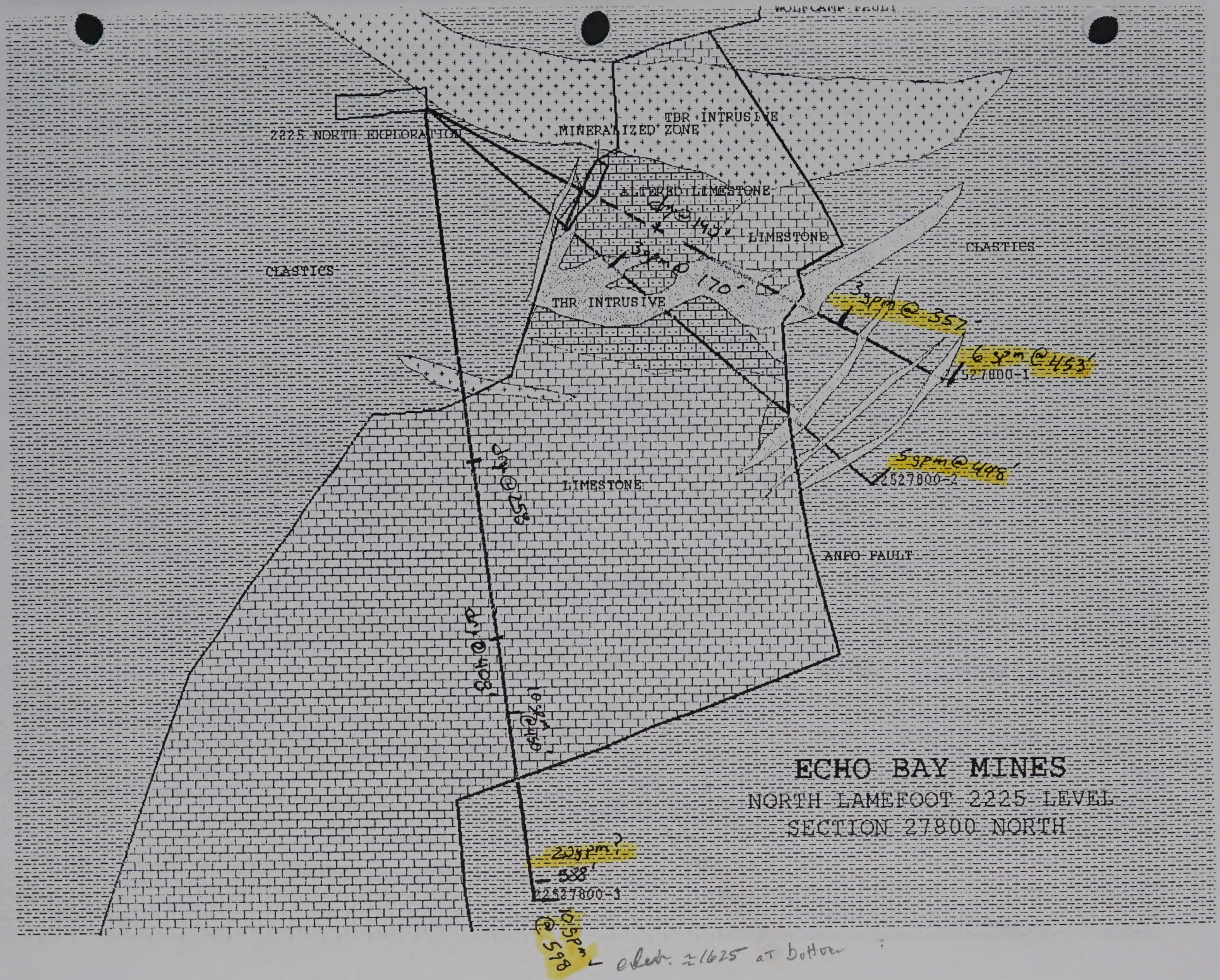
THR INTRUSIVE
22527300-1
MINERALIZED ZONE
ANFO FAULT
LIMESTONE
22527300-2
WOLFCAMP FAULT
2225 EXPLORATION
CLASTICS
TBR INTRUSIVE
22527300-3
ECHO BAY MINES
NORTH LAMEFOOT
SECTION 27300 NORTH
22527300-4

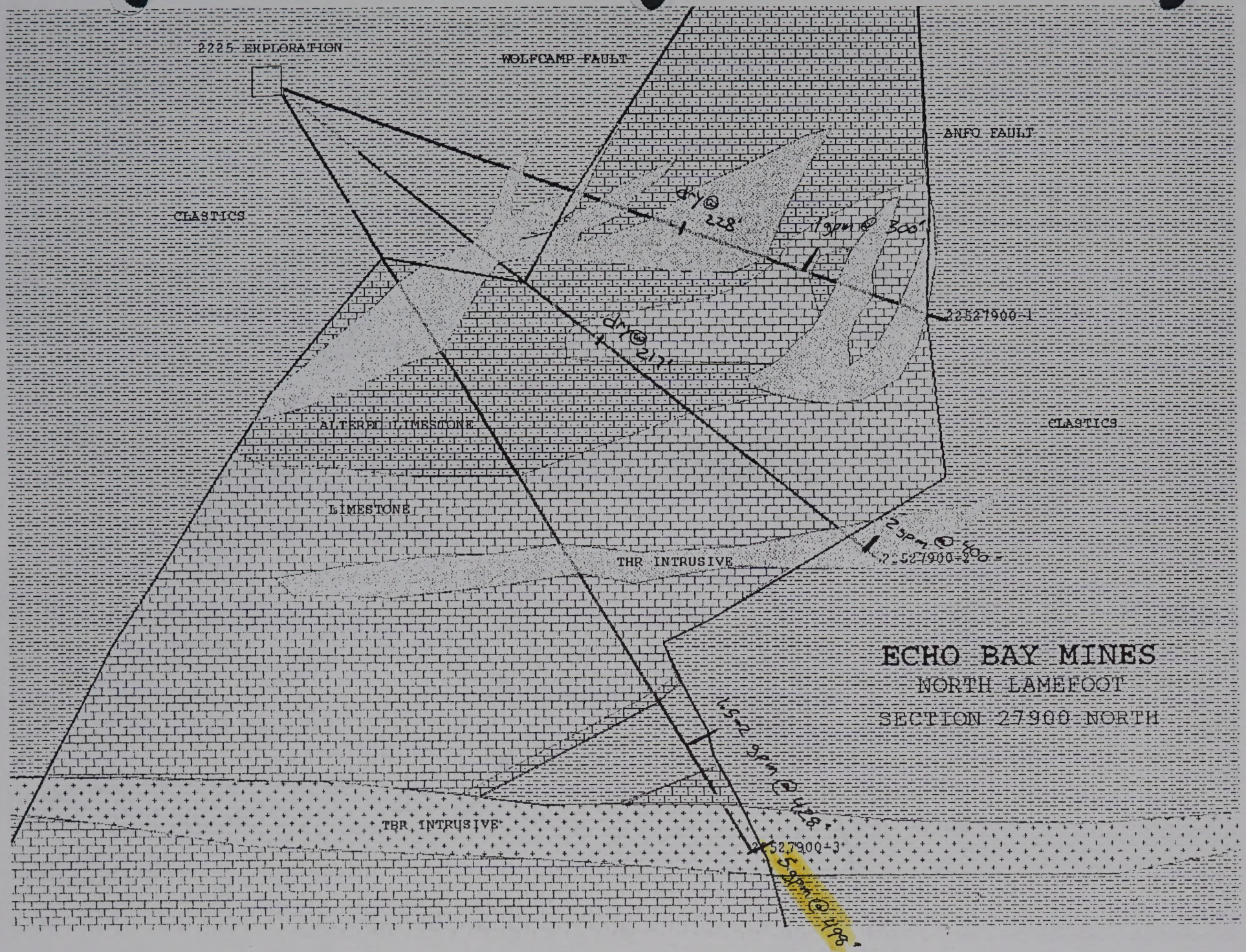

WOLFCAMP FAULT
CLASTICS
ALTERED LIMESTONE
MINERALIZED ZONES
THF INTRUSIVE
2225 EXPLORATION
22527400-2
22527400-3
TBR INTRUSIVE
CLASTICS
ANFO FAULT
22527400-4
LIMESTONE
22527400-1
ECHO BAY MINES
NORTH LAMEFOOT
SECTION 27400 NORTH

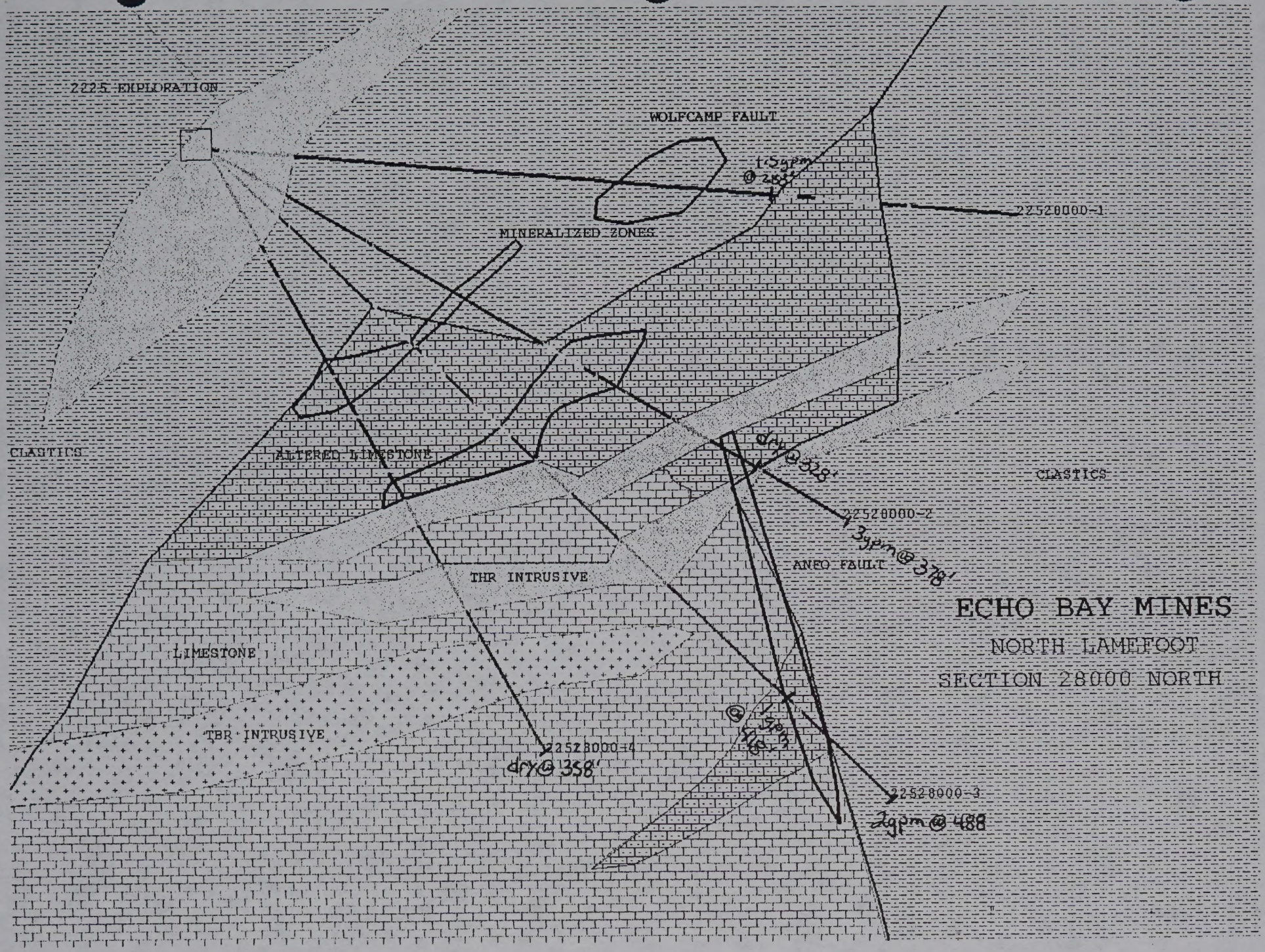

WOLFCAMP FAULT
THR INTRUSIVE
2225 EXPLORATION
TBR INTRUSIVE
MINERALIZED ZONES
22527500-4
no water
CLASTICS
ALTERED LIMESTONE
22527500-1
no water
LIMESTONE
22527500-2
no water
CLASTICS
ANFO FAULT
ECHO BAY MINES
NORTH LAMEFOOT
SECTION 27500 NORTH
22527500-3

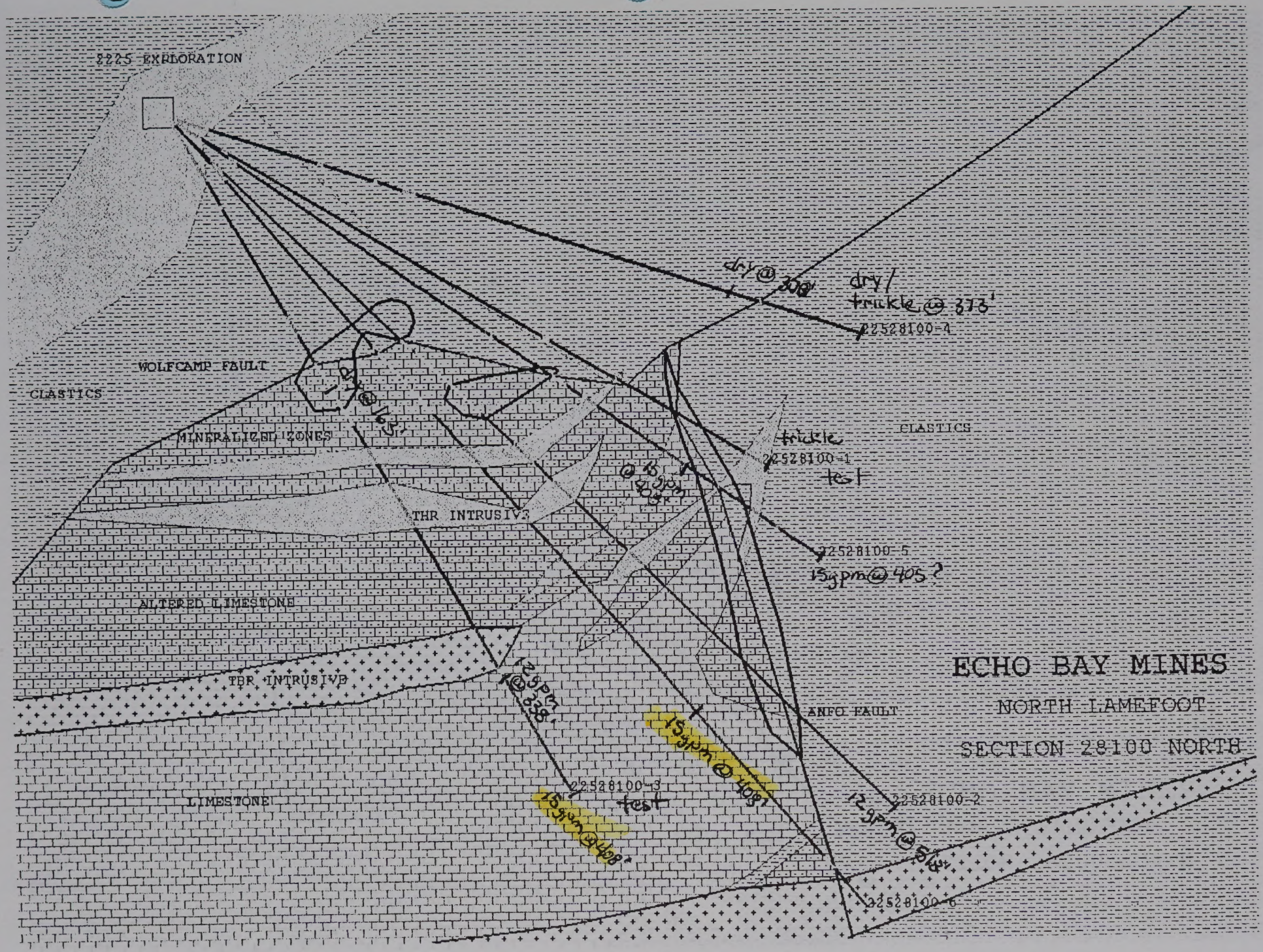

WOLFCAMP FAULT
27700-1
.5gpm @ 412'
27700-2
ANFO FAULT
2gpm @ 383'
27700-3
403'
THF INTRUSIVE
2225 EXPLORATION
ALTERED LIMESTONE
TBR INTRUSIVE
CLASTICS
3gpm @ 424'
27700-4
217' dry
247' dry
LIMESTONE
CLASTICS
27700-5
368' no water
ECHO BAY MINES
NORTH LAMEFOOT
SECTION 27700 NORTH

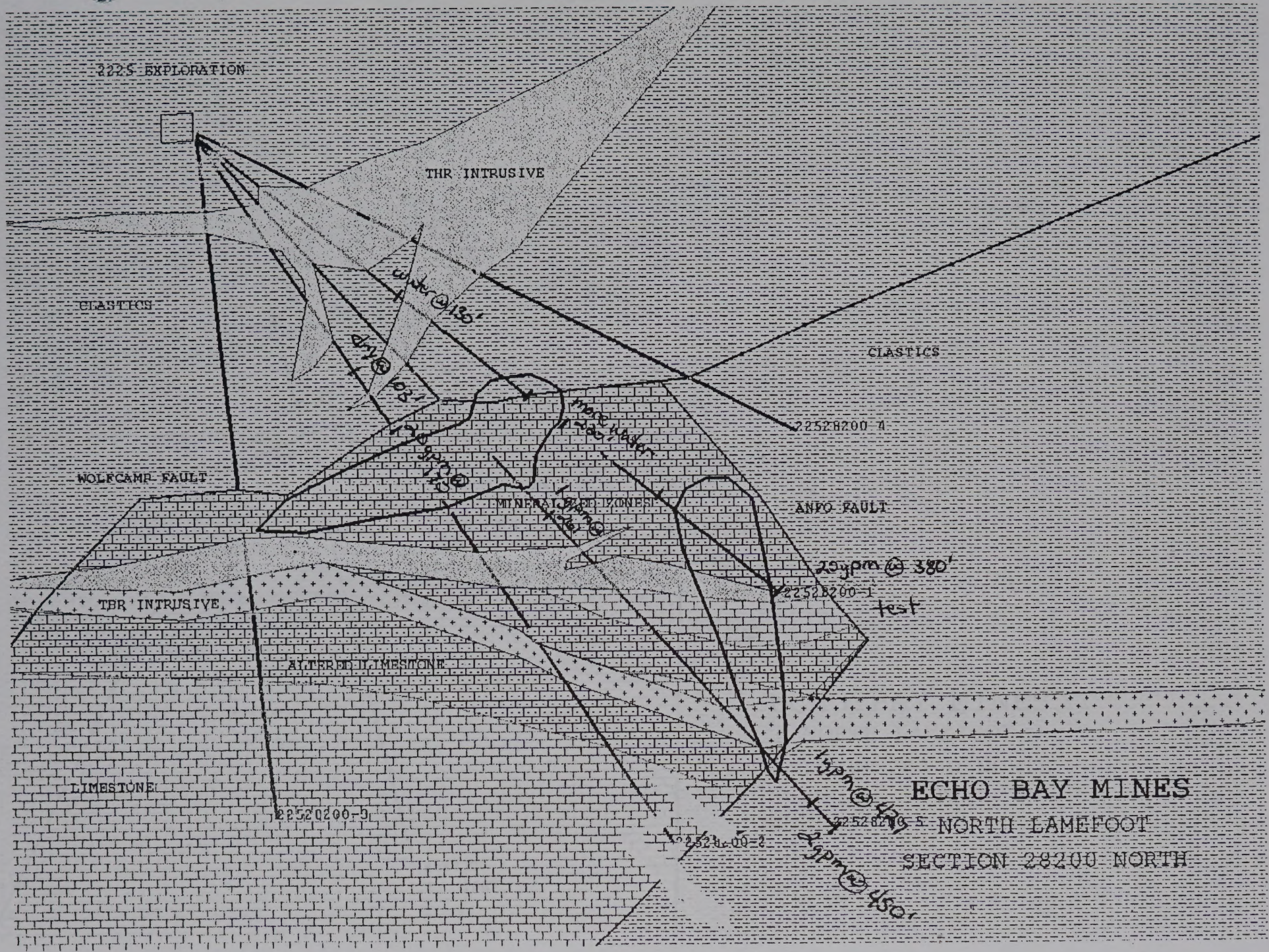


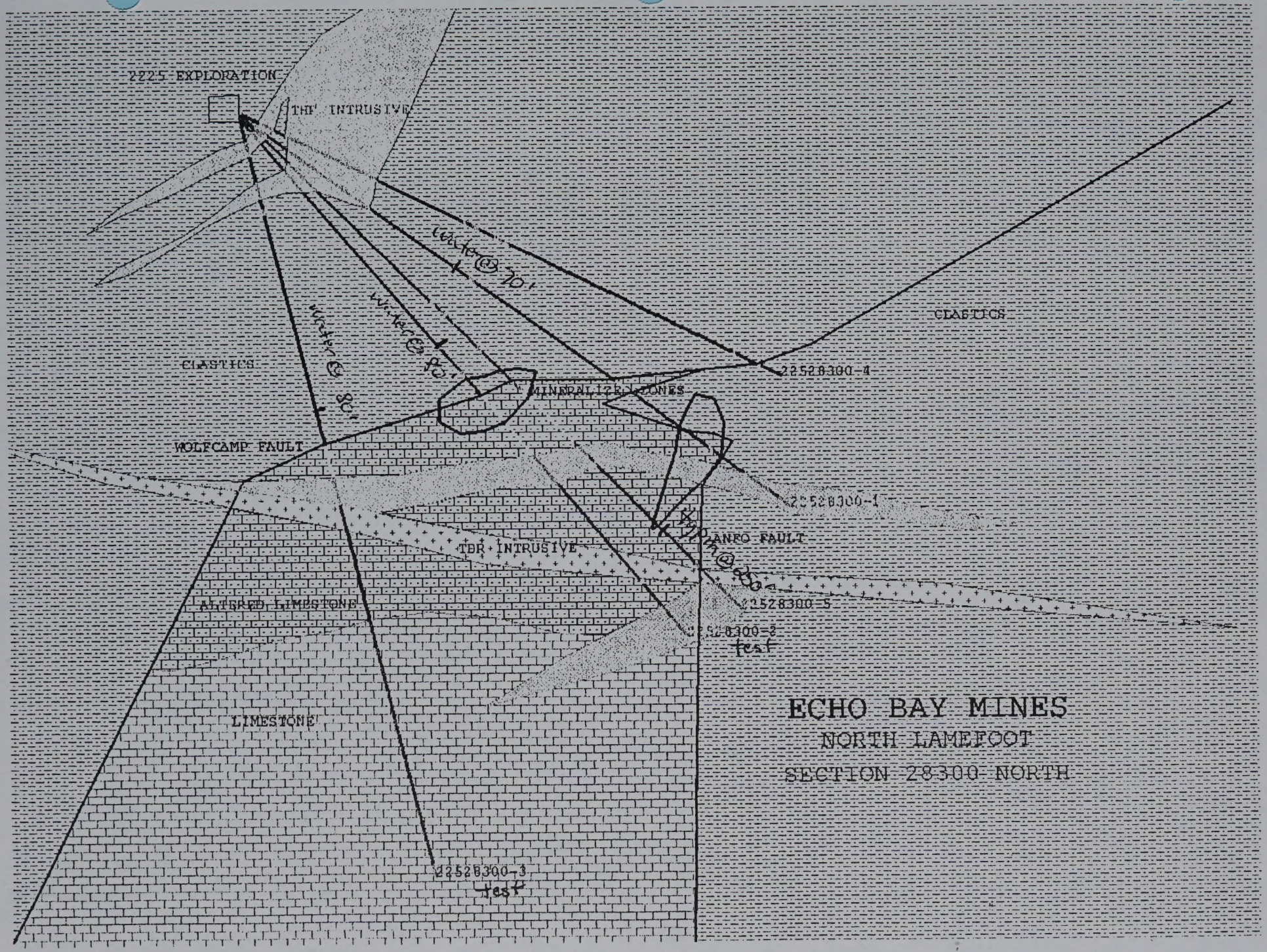
elev. ±1625 at bottom


2225 EXPLORATION
WOLFCAMP FAULT
ANFO FAULT
CLASTICS
dry @ 228'
1gpm @ 300'
22527900-1
dry @ 217'
ALTERED LIMESTONE
CLASTICS
LIMESTONE
THR INTRUSIVE
2gpm @ 400'
22527900-2
ECHO BAY MINES
NORTH LAMEFOOT
SECTION 27900 NORTH
1.5gpm @ 428'
THR INTRUSIVE
22527900-3
5gpm @ 498'


2225 EXPLORATION
WOLFCAMP FAULT
1.5gpm @ 283'
22520000-1
MINERALIZED ZONES
CLASTICS
ALTERED LIMESTONE
dry @ 328'
CLASTICS
22528000-2
3gpm @ 378'
ANEO FAULT
THR INTRUSIVE
ECHO BAY MINES
NORTH LAMEFOOT
SECTION 28000 NORTH
LIMESTONE
TBR INTRUSIVE
22528000-4
dry @ 358'
22528000-3
2gpm @ 488


8225 EXPLORATION
WOLFCAMP FAULT
CLASTICS
MINERALIZED ZONES
THR INTRUSIVE
ALTERED LIMESTONE
TBR INTRUSIVE
LIMESTONE
ANFO FAULT
CLASTICS
dry @ 308'
dry/ trickle @ 373'
22528100-4
trickle
22528100-1
test
22528100-5
15gpm @ 405 ?
22528100-3
test
22528100-2
22528100-6
ECHO BAY MINES
NORTH LAMEFOOT
SECTION 28100 NORTH


222S EXPLORATION
THR INTRUSIVE
CLASTICS
CLASTICS
22528200-4
WOLFCAMP FAULT
MINERALIZED ZONES
ANFO FAULT
20gpm @ 380'
test
22528200-1
TBR INTRUSIVE
ALTERED LIMESTONE
LIMESTONE
22520200-3
22528200-5
22528200-2
ECHO BAY MINES
NORTH LAMEFOOT
SECTION 2820U NORTH


2225 EXPLORATION
THF INTRUSIVE
CLASTICS
CLASTICS
MINERALIZED ZONES
WOLFCAMP FAULT
TDR INTRUSIVE
ALTERED LIMESTONE
LIMESTONE
22528300-4
22528300-1
22528300-5
22528300-2
test
22528300-3
test
ECHO BAY MINES
NORTH LAMEFOOT
SECTION 28300 NORTH

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 20
Mine Project: LAMEFOOT Date 6-28-97
Location: Republic Na Shift Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BWY A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	27-150-1	Core Boxes	Soluble Oil
Angle	+ 31	Cement	Drill Mud
Depth, End	220	Foods	Rod Lube
Depth, Begin	93	Grout Packer	Size
Drilled	127	Mech Packer	Size
Core Removed	127	Lost Circulation	
# of Runs		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S #
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 6½ HR Cementing ___
Reaming ___ Equip. Repair ___
Casing ___ Delays by Client ___
Setup, Tear Down 3½ HR STA MOVE Delays by Contractor ___
Hole Conditioning ___ Blast Delay ___
Survey ___ Other Delay ___
Other (Specify) ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BWY	183059	35 BITS	0	220	255
"	"	255	0		
		REAMING SHELLS			
BWY	P836	3010	0	220	3230
"	"	3230	0		

Remarks (Explain Delays)
Collar To Sill # 27-150-1 - 10' 4"

Driller Hellman Helper Peterson
Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 20
Mine Project: LAMEFOOT Date 6-29-9
Location: Republic Na Shift Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BWY A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #		Core Boxes	Soluble Oil
Angle		Cement	Drill Mud
Depth, End		Foods	Rod Lube
Depth, Begin		Grout Packer	Size
Drilled		Mech Packer	Size
Core Removed		Lost Circulation	
# of Runs		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S #
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling ___ Cementing ___
Reaming ___ Equip. Repair ___
Casing ___ Delays by Client ___
Setup, Tear Down 10 HR STA MOVE Delays by Contractor ___
Hole Conditioning DOWN RAMP Blast Delay ___
Survey ___ Other Delay ___
Other (Specify) ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
		BITS			
		REAMING SHELLS			

Remarks (Explain Delays) ___

Driller Hellman Helper Peterson
Approved by Client [signature]

DIAMOND DRILLING
SHIFT REPORT

Client: ECHO BAY — Job No. 20
Mine Project: LAMEFOOT — Date 6-26-97
Location: Relliff mo — Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BWTK ___ Other ___

HOLE INFO

Hole #	27-150-3	#2
Angle		
Depth, End	225	112
Depth, Begin	115	0
Drilled	108	112
Core Removed	108	112
# of Runs		

SUPPLIES

Core Boxes ___ Stainless Oil ___
Cement ___ Drill Mud ___
Foam ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S P ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	9 HR	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	1 HR	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BWTK	181493	314 BITS	0	883	532
"	"	532	0		

REAMING SHELLS

BWTK	P336	2568	0	223	2791
"	"	2791	0		

Remarks (Explain Delays)

Driller Hellman — Helper Peterson/Tressdell
Approved by Client: [signature]

DIAMOND DRILLING
SHIFT REPORT

Client: ECHO BAY — Job No. 20
Mine Project: LAMEFOOT — Date 6-27-9
Location: Relliff mo — Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BWTK ___ Other ___

HOLE INFO

Hole #	27-150-2	#1
Angle	-34	-31
Depth, End	219	93
Depth, Begin	112	0
Drilled	107	93
Core Removed	107	93
# of Runs		

SUPPLIES

Core Boxes ___ Stainless Oil ___
Cement ___ Drill Mud ___
Foam ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S P ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	9 HR	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	1 HR	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BWTK	181493	554 BITS	0	184	221
"	185059	NEW	184	219	35
"	"	35	0		

REAMING SHELLS

BWTK	P336	2791	0	219	3010
"	"	3010	0		

Remarks (Explain Delays)
COLLAR TO SILL #27-150-2 - 8'6"

Driller Hellman — Helper Peterson/Tressdell
Approved by Client: [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo BAY Job No. 20
Mine Project: LAMEFOOT Date 6-24-97
Location: Republic WA Shift Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO
Hole # 225-27-150-4
Angle -13
Depth, End 163
Depth, Begin 0
Drilled 163
Core Removed 163
# of Runs ___

SUPPLIES
Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fenchi ___ Fac Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S #
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)
Drilling 8Hr Cementing ___
Reaming ___ Equip. Repair ___
Casing ___ Delays by Client ___
Setup, Tear Down 2Hr Delays by Contractor ___
Hole Conditioning ___ Blast Delay ___
Survey ___ Other Delay ___
Other (Specify) ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	L81493	61 BITS	0		

REAMING SHELLS

BW44	P336	2315	0		

Remarks (Explain Delays)
collar To Sill # 225-27-150-4 - 4'6"

Driller Hellman Helper Truesdell
Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo BAY Job No. 20
Mine Project: LAMEFOOT Date 6-25-9
Location: Republic WA Shift Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO
Hole # 27-150-4 | # 3
Angle -13 | +15
Depth, End 253 | 115
Depth, Begin 163 | 0
Drilled 90 | 115
Core Removed 90 | 115
# of Runs ___

SUPPLIES
Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fenchi ___ Fac Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S #
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)
Drilling 9Hr Cementing ___
Reaming ___ Equip. Repair ___
Casing ___ Delays by Client ___
Setup, Tear Down 1Hr Delays by Contractor ___
Hole Conditioning ___ Blast Delay ___
Survey ___ Other Delay ___
Other (Specify) ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	L81493	61 BITS	0	253	3
"	"	314	0		

REAMING SHELLS

BW44	P336	2315	0	253	25
"	"	2568	0		

Remarks (Explain Delays)
Collar To Sill # 27-150-3 - 7'2"

Driller Hellman Helper Truesdell
Approved by Client [signature]

SHIFT REPORT

Client: ECHO BAY Job No: 20
Mine Project: LAME FOOT Date: 8-1-97
Location: Republic Shift: Day ✓ Swing ___ Graveyard ___
Hole Size: HQ ___ NTW ___ NQ ___ BQ/NQ/A ___ Other ___

HOLE INFO
Hole #: 225-27-300-1
Angle: +18
Depth, End: 78
Depth, Begin: 0
Drilled: 78
Core Removed: 78
# of Runs: ___

SUPPLIES
Core Boxes ___ Stabiliz. Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Quick Plaster ___ Size ___
Mech. Plaster ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ OS #
Overall Drilled ___ From ___ To ___

TIME CHARGES (Hours)
Drilling: 5 HR
Reaming ___
Casing ___
Setup, Tear Down: 6 HR
Hole Conditioning ___
Survey ___
Other (Specify) ___
Cementing ___
Equip. Repair ___
Delays by Client ___
Delays by Contractor ___
Bad Ground ___
Other Delay: 1 HR Bar Bound

Size	Serial No.	Previous Footage	On	Off	Total Footage
BQ/A	L85593	533 BITS	0		

REAMING SHELLS

BQ/A	P1266	1921	0		

Remarks (Explain Delays):

Driller: HELLMAN Helper: LUTZ
Approved by Client: [signature]

SHIFT REPORT

Client: ECHO BAY Job No: 20
Mine Project: Lame Foot Date: 8-2-97
Location: Republic Shift: Day ✓ Swing ___ Graveyard ___
Hole Size: HQ ___ NTW ___ NQ ___ BQ/NQ/A ___ Other ___

HOLE INFO
Hole #: 225-27-300-1
Angle: +18
Depth, End: 158
Depth, Begin: 78
Drilled: 80
Core Removed: 80
# of Runs: ___

SUPPLIES
Core Boxes ___ Stabiliz. Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Quick Plaster ___ Size ___
Mech. Plaster ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ OS #
Overall Drilled ___ From ___ To ___

TIME CHARGES (Hours)
Drilling: 9 - Remarks
Reaming ___
Casing ___
Setup, Tear Down ___
Hole Conditioning ___
Survey ___
Other (Specify): 1 - MAKE TRIP for Core Barrel
Cementing ___
Equip. Repair ___
Delays by Client ___
Delays by Contractor ___
Bad Ground ___
Other Delay ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BQ/A	L85593	533 BITS	0	110	0 to 110 / 643
" "	L85594	NEW	110	145	0 to 40 / 35
" "	L85592	[illegible]	[illegible]	[illegible]	[illegible]
" "	L85595	NEW	181	[illegible]	60 [illegible]

REAMING SHELLS

BQ/A	P1266	1921	0		

Remarks (Explain Delays): Hard Broken up Rock
Short Runs.

Driller: Williams Helper: Peterson
Approved by Client: [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 20
Mine Project: Lame Foot Date: 8-3-97
Location: Republic, WA Shift Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ B W44 A ___ Other ___

HOLE INFO
Hole # 225-27-300-1
Angle +18
Depth, End 248
Depth, Begin 158
Drilled 90
Core Removed 90
# of Runs ___

SUPPLIES
Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fence ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S #
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)
Drilling 9 1/2 SOS.
Reaming ___
Casing ___
Setup, Tear Down ___
Hole Conditioning ___
Survey ___
Other (Specify) ___
Cementing ___
Equip. Repair Yardsist chains
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ___

Size	Serial No.	Previous Footage		On	Off	Total Footage
Bw44	L85595	New	BITS	151	202	51
" "	L85596	New		202		

REAMING SHELLS

Bw44	P1266	1921		0		

Remarks (Explain Delays) 9 Gallons Diesel
Collar To Sill hole #1 is 7'
got out of real hard rock 4235'

Driller Williams Helper Peterson
Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo BAY Job No. 20
Mine Project: LAME FOOT Date: 8-4-97
Location: Republic, WA Shift Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ B W44 A ___ Other ___

HOLE INFO
Hole # 27-300-1
Angle +18
Depth, End 307 EOC
Depth, Begin 248
Drilled 59
Core Removed 59
# of Runs ___

SUPPLIES
Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fence ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S #
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)
Drilling 10 HP
Reaming ___
Casing ___
Setup, Tear Down ___
Hole Conditioning ___
Survey ___
Other (Specify) ___
Cementing ___
Equip. Repair ___
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ___

Size	Serial No.	Previous Footage		On	Off	Total Footage
Bw44	L85596	New	BITS	202	307	10
"	"	105		0		

REAMING SHELLS

Bw44	P1266	1921		0	307	22
"	"	2228		0		

Remarks (Explain Delays) ___

Driller Hellman Helper ___
Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 20
Mine Project: Lamefoot — Date: 8-4-97
Location: Republic, WA — Shift Day ___ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ B ___ A ___ Other ___

HOLE INFO
Hole # 225-27-300 2
Angle +7
Depth, End 101
Depth, Begin 0
Drilled 101
Core Removed 101
# of Runs ___

SUPPLIES
Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fence ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ CSA
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)
Drilling 7 1/2 — Cementing ___
Reaming ___ — Equip. Repair ___
Casing ___ — Delays by Client 1. no compressed air
Setup, Tear Down 1/2 — Delays by Contractor ___
Hole Conditioning ___ — Blast Delay ___
Survey ___ — Other Delay 1/2 instal Packer
Other (Specify) 1/2 store core barrels

Size	Serial No.	Previous Footage	Cn	Off	Total Footage
BW44	L85596	105 BITS	0	82	187
BW44	L81504	New	82		

REAMING SHELLS

BW44	P1266	2228	0		

Remarks (Explain Delays) Cedar - sill hole #2 is 5'6" hard rock, but not like hole #1

Driller Williams — Helper Peterson
Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY — Job No. 20
Mine Project: LAMEFOOT — Date: 8-5-97
Location: Republic, WA — Shift Day ___ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO
Hole # 225-27-300-2
Angle +7
Depth, End 233 T.D.
Depth, Begin 101
Drilled 132
Core Removed 132
# of Runs ___

SUPPLIES
Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fence ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ CSA
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)
Drilling 9 hr — Cementing ___
Reaming ___ — Equip. Repair ___
Casing ___ — Delays by Client ___
Setup, Tear Down 1/2 hr — Delays by Contractor ___
Hole Conditioning ___ — Blast Delay ___
Survey ___ — Other Delay 1/2 instal Packer
Other (Specify) ___

Size	Serial No.	Previous Footage	Cn	Off	Total Footage
BW44	L81504	New BITS	82	107	25
"	L81506	New	107	233	126
"	"	126	0		

REAMING SHELLS

BW44	P1266	2228	0	233	2461
"	"	2461	0		

Remarks (Explain Delays) ___

Driller HEUMAN — Helper LUTZ
Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 20-1
Mine Project: Lamefoot — Date 1-9-98
Location — Shift Day — Swing ✓ — Grave
Hole Size: HC — NTW — NQ — BW44 A — Other

HOLE INFO
Hole # 27-300-3
Angle -25
Depth, End 250 Eon.
Depth, Begin 50
Drilled 200
Core Removed 200
# of Runs

SUPPLIES
Core Boxes — Soluble Oil
Cement — Drill Mud
Fence — Rod Lube
Grout Packer — Size
Mech Packer — Size
Lost Circulation
Other

Feet Reamed — From — To
Feet Cased — From — To — Size — C/S #
Cement Drilled — From — To

TIME CHARGES (Hours)
Drilling 9 — Cementing
Reaming — Equip. Repair
Casing — Delays by Client
Setup, Tear Down 1 — Delays by Contractor
Hole Conditioning — Blast Delay
Survey — Other Delay
Other (Specify)

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2549/2	340 BITS	0	250	590
" "	"	590			

REAMING SHELLS

BW44	P3002	6204	0	250	6454
" "	"	6454	0		

Remarks (Explain Delays) Set up + ready on next hole

Driller Williams — Helper Peterson
Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo BAY — Job No. 20
Mine Project: LAMEFOOT — Date 1-9-98
Location: 225 — Shift Day ✓ — Swing — Grave
Hole Size: HC — NTW — NQ — BW44 A — Other

HOLE INFO
Hole # 27-300-3
Angle -25
Depth, End 50
Depth, Begin 0
Drilled 50
Core Removed 50
# of Runs

SUPPLIES
Core Boxes — Soluble Oil
Cement — Drill Mud
Fence — Rod Lube
Grout Packer — Size
Mech Packer — Size
Lost Circulation
Other

Feet Reamed — From — To
Feet Cased — From — To — Size — C/S #
Cement Drilled — From — To

TIME CHARGES (Hours)
Drilling 2 Hr — Cementing
Reaming — Equip. Repair
Casing — Delays by Client
Setup, Tear Down 7 hr & set up Level move — Delays by Contractor
Hole Conditioning — Blast Delay
Survey — Other Delay 1 hr Take out 1 vpn Line
Other (Specify)

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2549/2	340 BITS	0		

REAMING SHELLS

BW44	P3002	6204	0		

Remarks (Explain Delays)

Driller Hellman — Helper Lessard
Approved by Client [signature]

DYNAMIC DRILLING

SHIFT REPORT

Client: ECHO BAY Job No. 20
Mine Project: LAMEFOOT Date: 1-10-98
Location: 225 Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	27-300-4	Core Boxes	Soluble Oil
Angle	-40	Cement	Drill Mud
Depth, End	300	Fencu	Rod Lube
Depth, Begin	0	Grout Packer	Size
Drilled	300	Mech. Packer	Size
Core Recovered	299	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ CS #
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	9 1/2 HR	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	1/2 HR BLOCKING	Delays by Contractor	
Hole Conditioning	CAME OUT	Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-254912	590 BITS	0	180	770
"	L85625	635	180	300	755
"	"	755	0		
		REAMING SHELLS			
BW44	P3002	6954	0	300	6754
"	"	6754	0		

Remarks (Explain Delays)

Driller: HELLMAN Helper: LESSARD

Approved by Clerk: [signature]

DYNAMIC DRILLING

SHIFT REPORT

Client: ECHO BAY Job No. 20
Mine Project: LAMEFOOT Date 7-1-97
Location: Republic Wa Shift Day ✓ Swing ___ Grvd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	27-~~350~~-1 400	Core Boxes	Soluble Oil
Angle	-45	Cement	Drill Mud
Depth, End	203	Fence	Red Lube
Depth, Begin	0	Grout Packer	Size
Drilled	203	Mech Packer	Size
Core Removed	203	Lost Circulation	
# of Rods			
		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ D/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	7½ Hr	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	2½ Hr	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	Dia	Off	Total Footage
BW44	L81492	120 BITS	0	188	Drill 308
"	L81494	New	188	203	15
"	"	15	0		
		REAMING SHELLS			
BW44	P336	3448	0	203	3651
"	"	3651	0		

Remarks (Explain Delays)
COLLAR TO SILL #27-350-1 - 0"

Driller Hellman Helper Truesdell
Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No: 20
Mine Project: LAMEFOOT Date: 7/1/97
Location: REPUBLIC WA Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BLUE A ___ Other ___

HOLE INFO 400

Hole #: 27-~~[illegible]~~-1
Angle: -55
Depth, End: 148
Depth, Begin: 0
Drilled: 145
Core Removed: 145
# of Runs: ___

SUPPLIES

Core Boxes ___ Schuole Oil ___
Cement ___ Drill Mud ___
Fonds ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C.S.#
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling: 7
Reaming: ___
Casing: ___
Setup, Tear Down: 3
Hole Conditioning: ___
Survey: ___
Other (Specify): ___
Cementing: ___
Equip. Repair: ___
Delays by Client: ___
Delays by Contractor: ___
Start Delay: ___
Other Delay: ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
Bw44	~~[illegible]~~	~~[illegible]~~ BITS	~~0~~		
11	L81494	15	0		

REAMING SHELLS

Bw44	P336	3,651	0		

Remarks (Explain Delays): Sell to Collar for hole number 27-400-1 is 6 in

Driller: [signature] Helper: [signature]
Approved by Client: [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo BAY Job No: 20
Mine Project: LAMEFOOT Date: 7-2-97
Location: Republic WA Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BLUE A ___ Other ___

HOLE INFO

Hole #: 27-400-1
Angle: -55
Depth, End: 218
Depth, Begin: 148
Drilled: 70
Core Removed: 70
# of Runs: ___

SUPPLIES

Core Boxes ___ Schuole Oil ___
Cement ___ Drill Mud ___
Fonds ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C.S.#
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling: 5 Hr
Reaming: ___
Casing: ___
Setup, Tear Down: 4 hr Level move
Hole Conditioning: ___
Survey: 2225 [illegible]
Other (Specify): [illegible]
Cementing: ___
Equip. Repair: 1 hr leak in [illegible]
Delays by Client: [illegible]
Delays by Contractor: ___
Start Delay: ___
Other Delay: ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
Bw44	L81494	15 BITS	0	218	233
11	11	233	0		

REAMING SHELLS

Bw44	P336	3651	0	218	3869
11	11				

Remarks (Explain Delays): ___

Driller: Hellman Helper: Truesdell
Approved by Client: R. L[illegible]

REPORT

Client: Echo Bay — Job No.:
Mine Project: Lame Foot — Date: 8-25-97
Location: Republic, WA — Shift Day ✓ — Swing — Grvyd.
Hole Size: HQ — NTW — NQ — B WAY A — Other

HOLE INFO			SUPPLIES	
Hole #	225-27-400-2	4 3	Core Boxes	Soluble Oil
Angle	0	-25	Cement	Drill Mud
Depth, End	173	14	Fondu	Rod Lube
Depth, Begin	40	0	Grout Packer	Size
Drilled	133	14	Mech Packer	Size
Core Removed	133	14	Lost Circulation	
# of Runs			Other	

Feet Reamed — From — To
Feet Cased — From — To — Size — C/S #
Cement Drilled — From — To

TIME CHARGES (Hours)

Drilling: 8 1/2 — Cementing
Reaming — Equip. Repair
Casing — Delays by Client
Setup, Tear Down: 1 — Delays by Contractor
Hole Conditioning — Blast Delay
Survey — Other Delay: Reinstall Packer
Other (Specify)

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW44	7-18-12/01	NEW	BITS	38	68	30 DEAD
" "	7-18-1/02	NEW		68	173	105
" "	" " 7AA	105		0		
			REAMING SHELLS			
BW44	P1268	1027		0	173	1200
" "	" "	1200				

Remarks (Explain Delays): Collar - Sill hole #3 in 3' 2"
Need more Packers - out

Driller: Williams — Helper: Peterson
Approved by Client: [signature]

SHIFT REPORT

Client: Echo Bay — Job No.: 20
Mine Project: Lame Foot — Date: 8-24-97
Location: Republic, WA — Shift Day ✓ — Swing — Grvyd.
Hole Size: HQ — NTW — NQ — B WAY A — Other

HOLE INFO			SUPPLIES	
Hole #	225-27-315-5	225-27-400-2	Core Boxes	Soluble Oil
Angle	-50	0	Cement	Drill Mud
Depth, End	303	40	Fondu	Rod Lube
Depth, Begin	228	40	Grout Packer	Size
Drilled	75	40	Mech Packer	Size
Core Removed	75		Lost Circulation	
# of Runs			Other	

Feet Reamed — From — To
Feet Cased — From — To — Size — C/S #
Cement Drilled — From — To

TIME CHARGES (Hours)

Drilling: 9 — Cementing
Reaming — Equip. Repair
Casing — Delays by Client
Setup, Tear Down: 1 — Delays by Contractor
Hole Conditioning — Blast Delay
Survey — Other Delay
Other (Specify)

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW44	7-18-13/01	NEW	BITS	28	303	275
" "	" "	275		0	38	303 Dead
BW44	7-18-12/01	NEW		38		
			REAMING SHELLS			
BW44	P1268	724		0	303	1027
" "	" "	1027		0		

Remarks (Explain Delays): Collar to sill hole 225-27-400-2 is 4' 8"

Driller: Williams — Helper: Peterson
Approved by Client: [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 20
Mine Project: Lame Foot Date 8-26-97
Location: Republic, WA Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ B 2.44 A ___ Other ___

HOLE INFO	225-27	225-27
Hole #	450-3	450-3
Angle	-25	-17
Depth, End	89	37
Depth, Begin	14	0
Drilled	75	37
Core Removed	75	37
# of Runs		
	112	

SUPPLIES			
Core Boxes		Soluble Oil	
Cement		Drill Mud	
Fence		Rod Lube	
Grout Packer		Size	
Mech. Packer		Size	
Lost Circulation			
Other			

Feet Reamed ___ From ___ To ___
Feet Cored ___ From ___ To ___ Size ___ DS #
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Setting 9 Cementing ___
Reaming ___ Equip. Repair ___
Casing ___ Delays by Client ___
Setup, Tear Down 1 Delays by Contractor ___
Hole Conditioning ___ Blast Delay ___
Survey ___ Other Delay ___
Other (Specify) ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
B 2.44	7-18-1/02	105 BITS	0	33	138 Dead
DW 44	7-18-2/02	New	53	89	56
" "	" "				
		56	0		
REAMING SHELLS					
B 2.44	P1268	1200	0	89	1289
" "	" "	1289			

Remarks (Explain Delays) Collar to sill hole #225-27 -450-3 is 3'6"

Driller Williams Helper Peterson

Approved by Client [signature]

SHIFT REPORT

Client: ECHO BAY Job No. 20
Mine Project: LAMEFOOT Date: 9/3/97
Location: Republic Zn Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO
Hole # 225-27-400-4
Angle -40
Depth, End 308
Depth, Begin 18
Drilled 190
Core Removed 190
# of Runs ___

SUPPLIES
Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)
Drilling 10 Hr Cementing ___
Reaming ___ Equip. Repair ___
Casing ___ Delays by Client ___
Setup, Tear Down ___ Delays by Contractor ___
Hole Conditioning ___ Blast Delay ___
Survey ___ Other Delay ___
Other (Specify) ___

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW44	7-1813/12	193	BITS	0	158	351
"	L851/20	New		158	208	50
"	"	50		0		

REAMING SHELLS

BW44	P1268	1884	0	208	2092
"	"	2092	0		

Remarks (Explain Delays) COLLAR TO SILL 27-400-4-13
from hole (225 [illegible])
[illegible]
[illegible] 2

Driller Hellman Helper LUTZ
Approved by Client [signature]

SHIFT REPORT

Client: ECHO BAY Job No. 20
Mine Project: LAMEFOOT Date: 9-2-97
Location: Republic Zn Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO 27-400-4
Hole # 225-27-425-2 | 4
Angle -40 | -40
Depth, End 223 | 18
Depth, Begin 123 | 0
Drilled 100 | 18
Core Removed 100 | 18
# of Runs ___

SUPPLIES
Core Boxes ___ Soluble O. ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)
Drilling 8½ Hr Cementing ___
Reaming ___ Equip. Repair ___
Casing ___ Delays by Client ___
Setup, Tear Down 1 Hr Delays by Contractor ___
Hole Conditioning ___ Blast Delay ___
Survey ___ Other Delay 1 Hr INSTALL PACK
Other (Specify) ___

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW44	7-1813/02	New	BITS	30	223	193
"	"	193		0		

REAMING SHELLS

BW44	P1268	1661	0	223	188
"	"	1884	0		

Remarks (Explain Delays) ___

Driller Hellman Helper LUTZ
Approved by Client [signature]

SENT BY: 3-12-98 ; 4:51PM ; 0019703496334;#23
MAR 12 98 17:36 No.008 P.23

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY — Job No: 20
Mine Project: LAMEFOOT — Date: 1-21-98
Location: 225 — Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ B W44 A ___ Other ___

HOLE INFO
Hole #: 27-400-6
Angle: -43
Depth, End: 258
Depth, Begin: 158
Drilled: 100
Core Removed: 100
# of Runs: ___

SUPPLIES
Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech. Packer ___ Size ___
Lost Circulation ___
Other: 1082 Diesel

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S #
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)
Drilling: 8½ hr — Cementing ___
Reaming ___ — Equip. Repair: 1 hr End Holder B.O. Washers
Casing ___ — Delays by Client ___
Setup, Tear Down: ½ hr — Delays by Contractor ___
Hole Conditioning ___ — Blast Delay ___
Survey ___ — Other Delay ___
Other (Specify) ___

Size	Serial No.	Previous Footage	BITS On	Off	Total Footage
BW44	7/2549/5	New	158	208	50 T
"	L94553	New	208	258	50
"	"	50	0		

REAMING SHELLS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	P3460	1806	0	258	2064
"	"	2064	0		

Remarks (Explain Delays): ___

Driller: HELLMAN — Helper: LESSARD
Approved by Client: [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No: 20-1
Mine Project: Lamefoot — Date: 1-20-98
Location: ___ — Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ B W44 A ___ Other ___

HOLE INFO
Hole #: 27-400-6
Angle: -43
Depth, End: 158
Depth, Begin: 0
Drilled: 158
Core Removed: 158
# of Runs: ___

SUPPLIES
Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech. Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S #
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)
Drilling: 9 — Cementing ___
Reaming ___ — Equip. Repair ___
Casing ___ — Delays by Client ___
Setup, Tear Down: 1 — Delays by Contractor ___
Hole Conditioning ___ — Blast Delay ___
Survey ___ — Other Delay ___
Other (Specify) ___

Size	Serial No.	Previous Footage	BITS On	Off	Total Footage
BW44	L93829	40	0	158	192 Dis.
" "	7-2549/5	new	158		

REAMING SHELLS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	P3460	1806	0		

Remarks (Explain Delays): Collar-Sill hole #6 is 10" Hard Rock

Driller: Williams — Helper: Peterson
Approved by Client: [signature]

SENT BY: 3-12-98 ; 4:50PM ; 0019703496334;#22

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 20
Mine Project: LAMEFOOT — Date: 1-26-98
Location: 225 — Shift Day ✓ — Swing ___ — Swyd ___
Hole Size: HQ ___ NTW ___ NQ ___ B ___ A ___ Other ___

HOLE INFO
Hole #: 27-400-5
Angle: -32
Depth, End: 242
Depth, Begin: 166
Drilled: 106
Core Removed: 106
# of Runs: ___

SUPPLIES
Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ CS #
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)
Drilling: 9½ HR
Reaming ___
Casing ___
Setup, Tear Down: ½ HR
Hole Conditioning ___
Survey ___
Other (Specify) ___
Cementing ___
Equip. Repair ___
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BWH	7/2549/4	New	166	232	66T
"	193829	New	232	272	40
"	"	40	0		

REAMING SHELLS

BWH	P3460	1534	0	272	1806
"	"	1806	0		

Remarks (Explain Delays): Hard Rock

Driller: Hellman — Helper: Lessard
Approved by Client: [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 20-1
Mine Project: Lamefoot — Date: 1-19-98
Location ___ — Shift Day ___ — Swing ✓ — Swyd ___
Hole Size: HQ ___ NTW ___ NQ ___ B ___ A ___ Other ___

HOLE INFO
Hole #: 27-400-5
Angle: -32
Depth, End: 166
Depth, Begin: 0
Drilled: 166
Core Removed: 166
# of Runs: ___

SUPPLIES
Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ CS #
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)
Drilling: 7½
Reaming ___
Casing ___
Setup, Tear Down: 2½
Hole Conditioning ___
Survey ___
Other (Specify) ___
Cementing ___
Equip. Repair ___
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BWH	L94550	301	0	166	467 Dia
BWH	7-2549/4	New	166		

REAMING SHELLS

BWH	P3460	1534	0		

Remarks (Explain Delays): Collar - Sill is 1" ...
Hard Rock

Driller: Williams — Helper: Peterson
Approved by Client: [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 21
Mine Project: Lake Cut Date: 2-24-98
Location: 2225 Shift: Day Swing Grave
Hole Size: HQ NTW NQ BQ-W A Other

HOLE INFO

Hole # 27-400-7
Angle -55°
Depth End 194
Depth Begin 0
Drilled 194
Core Retrieved 194
# of Runs

SUPPLIES

Core Boxes Soluble Oil
Cement Drill Mud
Ferro Rod Lube
Grout Packer Size
Mech Packer Size
Low Circulation
Other

Feet Reamed From To
Feet Cased From To Size CSG #
Cement Drilled From To

TIME CHARGES (Hours)

Drilling 7 1/2
Reaming
Casing
Setup, Tear Down 2 1/2 Setup
Hole Conditioning
Survey
Other (Specify)
Cementing
Equip. Repair
Delays by Client
Delays by Contractor
Blast Delay
Other Delay

Size	Serial No.	Previous Footage	BITS	Dr	Dil	Total Footage
BQ-W	L11406	71		0	133	204' T
	L12077	New		133'		

REAMING SHELLS

	P4850	2999'	0		

Remarks (Explain Delays): Collar to Sill is 1" Not making water.

Note: This hole was not supposed to be drilled first as per laminated schedule which directs to drill in order. Do not collar the final hole until geology approved.

Driller: Chris Helper: Robert Jones

Approved by Client: [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 21
Mine Project: Lake Cut Date: 2-25-98
Location: 2225 Shift: Day ✓ Swing Grave
Hole Size: HQ NTW NQ BQ-W A Other

HOLE INFO

Hole #	27-400-7	27-425-5
Angle	-55°	-53°
Depth End	298	37
Depth Begin	194	0
Drilled	104	37
Core Retrieved	104	37
# of Runs		

SUPPLIES

Core Boxes Soluble Oil
Cement Drill Mud
Ferro Rod Lube
Grout Packer Size
Mech Packer Size
Low Circulation
Other

Feet Reamed From To
Feet Cased From To Size CSG #
Cement Drilled From To

TIME CHARGES (Hours)

Drilling 8
Reaming
Casing
Setup, Tear Down 1
Hole Conditioning
Survey
Other (Specify)
Cementing
Equip. Repair 1
Delays by Client
Delays by Contractor
Blast Delay
Other Delay

Size	Serial No.	Previous Footage	BITS	Dr	Dil	Total Footage
BQ-W	L12077	New		133	298	165
	" "	165		0		

REAMING SHELLS

BQ-W	P4850	2999'	0	298	3297
	P4850	3297	0		

Remarks (Explain Delays): FRONT SPAC WENT LAST HOUR OF SHIFT.
COLLAR TO SILL ON 27-425-5 IS 12" HOLE NOT MAKING BOX WATER.

Driller: K. Decker Helper: Joscer

Approved by Client: [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 20
Project: LAMEFOOT Date 10-31-97
Location 225 Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO

Hole # 27-500-4
Angle -7
Depth, End 219
Depth, Begin. 9
Drilled 210
Core Removed 210
# of Runs

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 10 HR
Reaming
Casing
Setup, Tear Down
Hole Conditioning
Survey
Other (Specify)

Cementing
Equip. Repair
Delays by Client
Delays by Contractor
Blast Delay
Other Delay

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	~~7-2212/02~~	61	0	92	Dead/153
"	7-2211/4	319	92		

REAMING SHELLS

BW44	P3459	3392	0		

Remarks (Explain Delays) COLLAR TO SILL

Driller HELLMAN Helper LESSARD

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 20
Project: LAME FOOT Date 11-3-97
Location 225 Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	27-500-4	Core Boxes	Soluble Oil
Angle	-7	Cement	Drill Mud
Depth, End	336	Fondu	Rod Lube
Depth, Begin.	219	Grout Packer	Size
Drilled	117	Mech Packer	Size
Core Removed	117	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	9½ HR	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	½ HR Truck B.O. ON RAMP
Other (Specify)			

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW44	7-2211/4	319	BITS	92	297	524T
11	[illegible]	[illegible]				
	7-2315/2	NEW		297		
			REAMING SHELLS			
BW44	P3459	3392		0		

Remarks (Explain Delays) COLLAR TO SILL #27-500-4- 4' 4" HARD ROCK AT 296'

Driller HELLMAN Helper LESSARD

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client Echo Bay Job No. 20-1
Project: Lamefoot Date 11-5-97
Location Republic, WA Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ B W44 A ___ Other ___

HOLE INFO

Hole # 27-500-4
Angle -7
Depth, End 424 E.O.H.
Depth, Begin. 336
Drilled 88
Core Removed 88
# of Runs ___

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 9 1/2
Reaming ___
Casing ___
Setup, Tear Down 1/2
Conditioning ___
Survey ___
Other (Specify) ___
Cementing ___
Equip. Repair ___
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2315/2	NEW BITS	297	424	127
" "	" "	127	0		
		REAMING SHELLS			
BW44	P3459	3392	0	424	3816
"	" "	3816	0		

Remarks (Explain Delays) ___

Driller Williams Helper Peterson

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 20
Project: LAME FOOT Date 11-4-97
Location 825 Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ B W44 A ____ Other ____

HOLE INFO

Hole # 27-500-1
Angle -20
Depth, End 222
Depth, Begin. 0
Drilled 222
Core Removed 222
# of Runs ____

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 9 HR
Reaming ____
Casing ____
Setup, Tear Down 1 HR
Conditioning ____
Survey ____
Other (Specify) ____

Cementing ____
Equip. Repair ____
Delays by Client ____
Delays by Contractor ____
Blast Delay ____
Other Delay ____

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW44	7-2212/4	New	0		
"					
REAMING SHELLS					
BW44	P3459	3816T	—	—	—
"	P3001	New	0		

Remarks (Explain Delays) ____

Driller HELLMAN Helper LESSARD

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 20-1

Project: Lamefoot — Date 11-4-97

Location: Republic, WA — Shift: Day ___ Swing ✓ Grvyd ___

Hole Size: HQ ___ NTW ___ NQ ___ BW44 ___ A ___ Other ___

HOLE INFO

Hole # 27-500-1

Angle -20

Depth, End 327

Depth, Begin. 222

Drilled 105

Core Removed 105

# of Runs ___

SUPPLIES

Core Boxes ___ Soluble Oil ___

Cement ___ Drill Mud ___

Fondu ___ Rod Lube ___

Grout Packer ___ Size ___

Mech Packer ___ Size ___

Lost Circulation ___

Other ___

Feet Reamed ___ From ___ To ___

Feet Cased ___ From ___ To ___ Size ___ C/S # ___

Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 10 — Cementing ___

Reaming ___ — Equip. Repair ___

Casing ___ — Delays by Client ___

Setup, Tear Down ___ — Delays by Contractor ___

Hole Conditioning ___ — Blast Delay ___

Survey ___ — Other Delay ___

Other (Specify) ___

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2212/4	New	0	242	242 still good
BW44	7-2215/2	127	242		

REAMING SHELLS

BW44	P3001	New	0		

Remarks (Explain Delays) Hit hard Rock at 238

Driller Williams — Helper Peterson

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 20
Project: LAMEFOOT Date 11-5-97
Location 225 Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BLU 44 A ____ Other ____

HOLE INFO

Hole # 27-500-1
Angle -20
Depth, End 424
Depth, Begin. 327
Drilled 97
Core Removed 97
# of Runs ____

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 9 Hr
Reaming ____
Casing ____
Rig Up, Tear Down ____
Hole Conditioning ____
Survey ____
Other (Specify) ____

Cementing ____
Equip. Repair ____
Delays by Client ____
Delays by Contractor ____
Blast Delay ____
Other Delay 1 Hr SAFETY Meeting

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2315/2	127	242	336	221 T
11	7-2317/2	New	336		

REAMING SHELLS

BW44	P3001	New	0		

Remarks (Explain Delays) ____

Driller HELLMAN Helper LESSARD

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 20-1
Mine Project: Lamefoot — Date: 11-5-97
Location: Republic, WA — Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 ___ A ___ Other ___

HOLE INFO		
Hole #	27-500-1	T2
Angle	-20	-30
Depth, End	454	199
Depth, Begin.	424	0
Drilled	# 30	199
Core Removed	30	199
# of Runs		

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling: 9 1/2
Reaming ___
Casing ___
Setup, Tear Down: 1/2
Hole Conditioning ___
Survey ___
Other (Specify) ___

Cementing ___
Equip. Repair ___
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW44	7-2317/2	New	336	454	118
" "	" " "	118	0		
REAMING SHELLS					
BW44	P3001	New	0	454	454
" "	" "	454	0		

Remarks (Explain Delays): Collar - still hole # 2 is 23"

Driller: Williams — Helper: Peterson

Approved by Client: [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 20
Mine Project: LAMEFOOT Date 11-6-97
Location 225 Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	27-500-2	Core Boxes	
Angle	-30	Cement	
Depth, End	314	Fondu	
Depth, Begin.	199	Grout Packer	Size
Drilled	115	Mech Packer	Size
Core Removed	115	Lost Circulation	
# of Runs		Other	

Soluble Oil ___ Drill Mud ___ Rod Lube ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	9HR	Cementing	
Reaming		Equip. Repair	1HR Rod Holder
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2317/2	118	0	235	353T
11	7-2317/1	NEW	235		

REAMING SHELLS

BW44	P3001	454	0		

Remarks (Explain Delays)

Driller HEILMAN Helper LESSARD

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client Echo Bay Job No. 20-1
Mine Project: Lamefoot Date 11-6-97
Location Republic, WA Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ B W44 A ___ Other ___

HOLE INFO

Hole # 27-500-2
Angle -30
Depth, End 389
Depth, Begin. 314
Drilled 75
Core Removed 75
# of Runs ___

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 7
Reaming ___
Casing ___
Setup, Tear Down ___
Conditioning ___
Survey ___
Other (Specify) ___
Cementing ___
Equip. Repair 3 Rod holder
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
Bw44	7-2817/1	New ~~New~~ BITS	235		
		REAMING SHELLS			
Bw44	P3001	454	0		

Remarks (Explain Delays)

(Pat, 389 is TD! X)

Driller Williams Helper Peterson

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO BAY Job No. 20
Project: LAMEFOOT Date 11-7-97
Location 225 Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO

Hole # 27-500-3
Angle -45
Depth, End 189
Depth, Begin. 0
Drilled 189
Core Removed 189
# of Runs ___

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 6½ Hr
Reaming ___
Casing ___
Setup, Tear Down 1½ Hr
Conditioning ___
Survey ___
Other (Specify) ___
Cementing ___
Equip. Repair 2Hr Remarks
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2317/1	New BITS	235	389	154T
"	7-2211/6	7	0		
		REAMING SHELLS			
BW44	P3001	454	0	389	843
"	"	843	0		

Remarks (Explain Delays) Collar To Sill #27-500-1-3' Hole # 3-1' 3"
Change chuck Jaws change oil in Rotation unit

Driller Hellman Helper Lessard

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client Echo Bay Job No. 20-1
Project: Lame foot Date 11-7-97
Location Republic, WA Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ B W44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	27-500-3	Core Boxes	Soluble Oil
Angle	-45	Cement	Drill Mud
Depth, End	358	Fondu	Rod Lube
Depth, Begin.	189	Grout Packer	Size
Drilled	169	Mech Packer	Size
Core Removed	169	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-22 11/L	7 BITS	0		
		REAMING SHELLS			
BW44	P3001	843	0		

Remarks (Explain Delays) Broken up Rock

Driller Williams Helper Peterson

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client Echo BAY Job No. 20
Mine Project: LAMEFOOT Date 11-9-97
Location 225 Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ B BW44 A ___ Other ___

HOLE INFO

Hole # 27-500-3
Angle -45
Depth, End 424
Depth, Begin. 358
Drilled 66
Core Removed 66
# of Runs ___

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 6½ Hr
Reaming ___
Casing ___
Setup, Tear Down ___
Hole Conditioning ___
Survey ___
Other (Specify) ___

Cementing ___
Equip. Repair 3½ Hr Rod Holder
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2211/6	7 BITS	0		

REAMING SHELLS

BW44	P3001	843	0		

Remarks (Explain Delays) Put All New Washers In Rod Holder
service Both Tractors #1 oil & Filter & Fuel Filter Hr 302.8 And Air Cleaner Filter
#2 Hr 46 Grease

Driller Hellman Helper Lessard

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY — Job No. 20
Project: LAMEFOOT — Date 11-10-97
Location 226 — Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO

Hole #	27-500-3	27-525-1
Angle	-45	-5
Depth, End	484	119
Depth, Begin.	424	0
Drilled	60	119
Core Removed	60	119
# of Runs		

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 9HR — Cementing ____
Reaming ____ — Equip. Repair ____
Casing ____ — Delays by Client ____
Setup, Tear Down 1HR — Delays by Contractor ____
Hole Conditioning ____ — Blast Delay ____
Survey ____ — Other Delay ____
Other (Specify) ____

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW44	7-2211/6	7	0	484	491
"	"	491	0		
REAMING SHELLS					
BW44	P3001	843	0	484	1327
"	"	1327	0		

Remarks (Explain Delays) 13 Gal Diesel in Kubota #2.

Driller HEILMAN — Helper LESSARD

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 21
Mine Project: Lamefoot — Date 11-13-97
Location 2225 — Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW 44 A ___ Other ___

HOLE INFO

Hole # 27-700-1
Angle +27°
Depth, End 66
Depth, Begin. 0
Drilled 66
Core Removed 66
# of Runs

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 2
Reaming
Casing
Setup, Tear Down 5.5 Station move
Hole Conditioning
Survey
Other (Specify)

Cementing
Equip. Repair 1 1/2 - Hyd Fitting
Delays by Client 1 - No power
Delays by Contractor
Blast Delay
Other Delay

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW44	7-2211-7	250'	BITS	0		

REAMING SHELLS

BW-44	P-1270	2416'		0		

Remarks (Explain Delays): Electrician Had to come out to fix power. - Broke Hyd. Fitting Had to fab - New one. Hole not making any water @ 66'

Driller C. Jess — Helper K. Del Bolen

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAME FOOT Date 11-14-97
Location: Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW-44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	27-700-1	Core Boxes	Soluble Oil
Angle	+27°	Cement	Drill Mud
Depth, End	242 T.D.	Fondu	Rod Lube
Depth, Begin.	66	Grout Packer	Size
Drilled	176	Mech Packer	Size
Core Removed	176	Lost Circulation	
# of Runs		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW-44	7-2211-7	250	BITS	0	242	492'
			REAMING SHELLS			
BW-44	P-1270	2410		0	242	2652'

Remarks (Explain Delays) HOLE ISN'T MAKING ANY WATER AT 242'.

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 21
Mine Project: Lomekoot — Date 11-14-97
Location 2225 — Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW 44 A ___ Other ___

HOLE INFO

Hole # 27-700-2
Angle +19°
Depth, End 293
Depth, Begin. 0
Drilled 293
Core Removed 293
# of Runs

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 4
Reaming
Casing
Setup, Tear Down 1
Hole Conditioning
Survey
Other (Specify)

Cementing
Equip. Repair
Delays by Client
Delays by Contractor
Blast Delay
Other Delay

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2211-7	~~250'~~ BITS	0		
		492'			

REAMING SHELLS

BW-44	P-1270	~~2410'~~	0		
		2652'			

Remarks (Explain Delays) ~~Hole~~ #700-1 10' 1" From Collar to Sill # 700-2 8' to Sill. Not making any water @ 293

Driller C. Jess — Helper K. Dalbalcon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client Echo Bay Job No. 21
Mine Project: Lombroot Date 11-15-97
Location 2225 Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW-44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	27-700-2	Core Boxes	Soluble Oil
Angle	+ 19°	Cement	Drill Mud
Depth, End	412	Fondu	Rod Lube
Depth, Begin.	293	Grout Packer	Size
Drilled	119	Mech Packer	Size
Core Removed	119	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	8	Cementing	
Reaming		Equip. Repair	2
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW-44	7-2211-7	592'	BITS	0	413'	~~[illegible]~~ 1005T
			REAMING SHELLS			
11	P-1220	2652'		0		

Remarks (Explain Delays) 2hr. Lifter case stuck in Core Barrel (Trip outside for Core Barrel) Hole making @ 1/2 gal per min of water

Driller C. Jess Helper K. DalBalcon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHOBAY Job No. 21
Mine Project: LAME FOOT Date 11-17-97
Location _____ Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	27-700-3	Core Boxes	
Angle	+8°	Cement	
Depth, End	182	Fondu	
Depth, Begin.	0	Grout Packer	Size
Drilled	182	Mech Packer	Size
Core Removed	182	Lost Circulation	
# of Runs			
		Other	

Soluble Oil ____ Drill Mud ____ Rod Lube ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	8	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	2	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2211-08	NEW	0		

BITS

REAMING SHELLS

BW-44	P-1220	3,065	0		

Remarks (Explain Delays) COLLAR TO SILL IS 6' ON HOLE # 3. NO WATER AT 182'.

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client Echo Bay Job No. 21
Mine Project: Lame Foot Date 11-17-97
Location 2225 Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW 44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	27-700-3	Core Boxes	Soluble Oil
Angle	+8°	Cement	Drill Mud
Depth, End	383	Fondu	Rod Lube
Depth, Begin.	182	Grout Packer	Size
Drilled	201	Mech Packer	Size
Core Removed	201	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2211-8	New BITS	0	233'	233
	11	233'	263'	313	283 still good
BW44	L82297	New/30'	233'/313'	263'	30'
		REAMING SHELLS			
BW44	P-1270	3065'	0		

Remarks (Explain Delays) Hole making @ 2 gal min water at 383'

Driller C. Jess Helper K. Dolbalen

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY — Job No. 21
Mine Project: LAMEFOOT — Date 11-18-97
Location 2225 — Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 ✓ A ____ Other ____

HOLE INFO

Hole #	27-700-3	27-700-4
Angle	+8°	-15°
Depth, End	403 TD	213
Depth, Begin.	383	0
Drilled	20	213
Core Removed	20	213
# of Runs		

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 9
Reaming ____
Casing ____
Setup, Tear Down 1
Hole Conditioning ____
Survey ____
Other (Specify) ____

Cementing ____
Equip. Repair ____
Delays by Client ____
Delays by Contractor ____
Blast Delay ____
Other Delay ____

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	L-92297	30	313	403	120 still good
"	"	120	0		

REAMING SHELLS

BW-44	P-1270	3065	0	403	3468
" "	" "	3468	0		

Remarks (Explain Delays) COLLAR TO SILL IS 4 FT. ON HOLE #4 NOT MAKING ANY WATER AT 213' YET.

Driller K. DECKER — Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 2
Mine Project: Lone Foot Date 11-18-97
Location 2225 Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW 44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	27-700-4	Core Boxes	Soluble Oil
Angle	-15°	Cement	Drill Mud
Depth, End	424	Fondu	Rod Lube
Depth, Begin.	213	Grout Packer	Size
Drilled	211	Mech Packer	Size
Core Removed	211	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	L92297	120' BITS	0	~~[illegible]~~	~~[illegible]~~
				364'	484' T
	7-2211-8	used 233'	364'	424	293 still good
		REAMING SHELLS			
BW44	P-1270	3468'	0	424	3892'

Remarks (Explain Delays) Hole making @ 3 gal min of water @ 424'

Driller Cyfess Helper K. DeBolcom

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAMEFOOT Date 11-19-97
Location 2225 Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO

Hole # 27-200-5
Angle -42°
Depth, End 217
Depth, Begin. 0
Drilled 217
Core Removed 217
# of Runs ____

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 9
Reaming ____
Casing ____
Setup, Tear Down 1
Hole Conditioning ____
Survey ____
Other (Specify) ____

Cementing ____
Equip. Repair ____
Delays by Client ____
Delays by Contractor ____
Blast Delay ____
Other Delay ____

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW-44	7-2211-8	293	BITS	0	158	451T
BW-44	7-2315-03	40		158		

REAMING SHELLS

BW-44	P-1270	3892	0		

Remarks (Explain Delays) HOLE NOT MAKING ANY WATER AT 217'

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 21
Project: Lamefoot — Date 11-19-97
Location 2225 — Shift: Day ___ Swing ✓ ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW 44 A ___ Other ___

HOLE INFO

Hole # 27-700-5
Angle -42°
Depth, End 247
Depth, Begin. 217
Drilled 29
Core Removed 30
# of Runs

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation 10. Gal Desel
Other

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 2
Reaming
Casing
Rig Up, Tear Down 1 - Build Rod Deck
Hole Conditioning
Survey
Cementing
Equip. Repair
Delays by Client
Delays by Contractor
Blast Delay
Other Delay
Other (Specify) 3 - Help Hurt Back! Take to Hospital

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2315-03	40' BITS	158'		

REAMING SHELLS

BW44	R-1270	3892'	0		

Remarks (Explain Delays)

Driller C. Jess — Helper K. DalBakon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO BAY Job No. 21

Project: LAME FOOT Date 11-20-97

Location _____ Shift: Day ✓ Swing ____ Grvyd ____

Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	27-700-5	Core Boxes	Soluble Oil
Angle	-42°	Cement	Drill Mud
Depth, End	368 T.D.	Fondu	Rod Lube
Depth, Begin.	247	Grout Packer	Size
Drilled	121	Mech Packer	Size
Core Removed	121	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW-44	7-2315-03	40	BITS	158	368	[redacted]
						250 ST. 41 Cond
			REAMING SHELLS			
BW-44	P-1270	3892		0	368	4260

Remarks (Explain Delays) COLLAR TO SILL IS 27" INCHES.
HOLE # 5

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 21
Project: LameFoot — Date 11-5-97
Location 2225 — Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO

Hole # 27-800-1
Angle -27°
Depth, End 190
Depth, Begin. 0
Drilled 190
Core Removed 190
# of Runs

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 9
Reaming
Tripping
Setup, Tear Down 1/2
Hole Conditioning
Survey
Other (Specify)

Cementing
Equip. Repair 1/2 - Ajust Feed Chain
Delays by Client
Delays by Contractor
Blast Delay
Other Delay

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2315-1	270	0	92'	362T
BW-44	7-2316-1	New	92/190'	122'	30'
BW-44	7-2212-5	New	122	190	68' Still Good

REAMING SHELLS

BW44	P-1270	~~423~~ 95	0		

Remarks (Explain Delays) Collar on Hole 2.5' From Sill
Hole not making any water @ 190'
in & out of very Hard Rock from 85'-90'

Driller C. Jess — Helper K. DalBalcon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAME FOOT Date 11-6-97
Location ____ Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	27-800-1	Core Boxes	Soluble Oil
Angle	-27°	Cement	Drill Mud
Depth, End	357	Fondu	Rod Lube
Depth, Begin.	190	Grout Packer	Size
Drilled	167	Mech Packer	Size
Core Removed	167	Lost Circulation	
# of Runs		Other	

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2316-01	30	190		

BITS

REAMING SHELLS

BW-44	P-1270	921	0		

Remarks (Explain Delays) HOLE IS MAKING APROX. 3 GPM OF WATER

CHANGED OIL IN ROTATION UNIT

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 21
Mine Project: Lomefoot — Date 11-6-97
Location 2225 — Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW-44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	27-800-1 / 27-800-2	Core Boxes	Soluble Oil
Angle	-27° / -39°	Cement	Drill Mud
Depth, End	453 / 108	Fondu	Rod Lube
Depth, Begin.	357 / 0	Grout Packer	Size
Drilled	96 / 108	Mech Packer	Size
Core Removed	96 / 108	Lost Circulation	
# of Runs		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	9	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	1 Change angle	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW 44	7-2316-1	30	BITS	190	424	264' T
BW-44	7-2212-5	68'		424	453	97'
BW 44	7-2212-5	97'		0		
			REAMING SHELLS			
BW44	A1270	921		0	453	1374'
"	"	1374'		0		

Remarks (Explain Delays) 27-800-1 making 6 gal per min
27-800-2 21" From collar to Sill

Driller C. Jess — Helper K. DelBalcony
Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAME FOOT Date 11-7-97
Location ____ Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO

Hole # Z7-800-Z
Angle -39°
Depth, End 298
Depth, Begin. 108
Drilled 190
Core Removed 190
# of Runs ____

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 10
Reaming ____
Casing ____
Setup, Tear Down ____
Hole Conditioning ____
Survey ____
Other (Specify) ____

Cementing ____
Equip. Repair ____
Delays by Client ____
Delays by Contractor ____
Blast Delay ____
Other Delay ____

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW-44	7-2212-05	97	BITS	0	148	245T
" "	L-92296	NEW		148	288	140T
" "	7-2315-03	NEW		288		
			REAMING SHELLS			
BW-44	P-1270	1374		0		

Remarks (Explain Delays) HOLE IS MAKING ABOUT 3 G.P.M. of WATER AT ABOUT 170'

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING

SHIFT REPORT

Client: Echo Bay Rig No. 2

Area Project: Lakeshore Project Date: 11-7-72

Location: Elev. Gr. Elevation: Drilling

Hole Size: HQ RTW NQ RW NX A Other

HOLE INFO

Hole #: 72-EB-2

Angle: -30°

Depth Incl.: 278

Depth Begin: 108

Drilled: 170

Core Recovered: 170

# of Trips:

SUPPLIES

Core Boxes: Bentonite Oil

Cement: Drill Mud

Polymer: Rod Lube

Donut Packer: Pipe

Mech Packer: Sink

Tool Connection:

Other:

Fwd Reamed: From: To:

Fwd Cleaned: From: To: From: 108

Cleaned Drilled: From: To:

TIME CHARGES (Hours)

Drilling: 10 Connecting:

Reaming: Equip. Repair:

Coring: Delays by Driller:

Reaming Trip Down: Delays by Contractor:

Hole Conditioning: Rain Delay:

Survey: Other Delay:

Other (Specify):

Bit	Zone Nos.	Previous Footage	On	Off	Total Footage
RWV	72-212-05	27	0	197	197
" "	1-72-26	NEW	197	278	81
" "	72-2847-03	NEW	278		

REAMING SHELLS

RWV	F-1270	13 7/8	0

Remarks (Include Delays): Hole is 15 minutes behind schedule

G.F.M. ... Rig ... 12:20

Driller: K. Dekker Helper: J. Costello

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 21
Mine Project: Lame Foot Date 11-7-97
Location 2225 Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	27-800-2	Core Boxes	Soluble Oil
Angle	-39°	Cement	Drill Mud
Depth, End	448	Fondu	Rod Lube
Depth, Begin.	298	Grout Packer	Size
Drilled	150	Mech Packer	Size
Core Removed	150	Lost Circulation	
# of Runs		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	9	Cementing	
Reaming		Equip. Repair	1/2 Hyd Hose
Casing		Delays by Client	
Setup, Tear Down	1/2	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW44	7-2315-03	New	BITS	288	208	20' Still Good
	7-2316-02	New		308	448	140' Still Good
			REAMING SHELLS			
BW44	P-1270	1374		0	448	1822'

Remarks (Explain Delays) Hole making 5 gal per min water

Driller C. Jess Helper K. DelBalcon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO BAY Job No. 21

Mine Project: LAMETOOT Date 11-10-97

Location _____ Shift: Day ✓ Swing ____ Grvyd ____

Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	27-800-3	Core Boxes	
Angle	-83°	Cement	
Depth, End	258	Fondu	
Depth, Begin.	0	Grout Packer	Size
Drilled	258	Mech Packer	Size
Core Removed	257	Lost Circulation	
# of Runs			
		Other	

Soluble Oil ____ Drill Mud ____ Rod Lube ____

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2316-02	140	BITS 0	218	358T
" "	7-2315-03	20	218	238	40 STILL GOOD
" "	7-2211-07	NEW	238		
			REAMING SHELLS		
BW-44	P-1270	1822	0		

Remarks (Explain Delays) HOLE NOT MAKING ANY WATER AT 258'

Driller K. DECKER Helper J. OSLER

Approved by Client

DYNAMIC DRILL..G

SHIFT REPORT

Client Echo Bay Job No. 21

Mine Project: Lomestoot Date 11-10-97

Location _____ Shift: Day ____ Swing ✓ Grvyd ____

Hole Size: HQ ____ NTW ____ NQ ____ B ____ A ____ Other ____

HOLE INFO		SUPPLIES			
Hole #		Core Boxes		Soluble Oil	
Angle		Cement		Drill Mud	
Depth, End		Fondu		Rod Lube	
Depth, Begin.		Grout Packer		Size	
Drilled		Mech Packer		Size	
Core Removed		Lost Circulation			
# of Runs					
		Other			

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling		Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)	2 - Show up time		

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
REAMING SHELLS					

Remarks (Explain Delays) Helper Hurt Hand, could not work

Driller C. Jess Helper [illegible]

Approved by Client

DYNAMIC DRILL, D

DAILY REPORT

Client _____ Job No. _____

Area Project _____ Date _____

Location _____ Start Day ____ Swing ____ End ____

Hole Size HO ____ RTW ____ HO ____ R ____ A ____ Other _____

HOLE INFO	SUPPLIES
Hole # _____	Core Barrel _____ Solids On _____
Angle _____	Cement _____ Old Mud _____
Dress, Ens _____	Fluids _____ Fed Lube _____
Depth Drlgn _____	Donut Packer _____ Size _____
Drilled _____	Mech Packer _____ Size _____
Core Recovered _____	Lost Circulation _____
# of Runs _____	_____
	Other _____

Feet Reamed _____ From _____ To _____

Feet Cored _____ From _____ To _____ Size _____ CS #

Cement Drilled _____ From _____ To _____

TIME CHARGES (Hours)

Drilling	_____	Cementing	_____
Reaming	_____	Equip. Repair	_____
Coring	_____	Delays by Client	_____
Setup, Tear Down	_____	Delays by Contractor	_____
Hole Conditioning	_____	Total Delay	_____
Survey	_____	Other Delay	_____
Other (Specify)	_____		

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage

REAMING SHELLS

Remarks (Fluids Delays) _____

Driller _____ Helper _____

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAMEFOOT Date 11-9-97
Location 2225 Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	27-800-3	Core Boxes	
Angle	-83°	Cement	
Depth, End		Fondu	
Depth, Begin.		Grout Packer	Size
Drilled		Mech Packer	Size
Core Removed		Lost Circulation	
# of Runs			
		Other	

Soluble Oil ____
Drill Mud ____
Rod Lube ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling		Cementing	
Reaming		Equip. Repair	7
Casing		Delays by Client	
Setup, Tear Down	3	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) ____

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
REAMING SHELLS					

Remarks (Explain Delays) 7 HRS. SERVICE KUBOTA. REPLACE BUSHINGS IN ROTATION UNIT HOUSING. SHORTEN FEED CHAINS
KUBOTA - CHANGED OIL, REPLACED FUEL FILTER + AIR FILTER + GREASED AT 302.8 HR.

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILL[illegible]G
SHIFT REPORT

Client ECHO BAY Job No. 21

Mine Project: LAME FOOT Date 11-11-97

Location _____ Shift: Day ✓ Swing ____ Grvyd ____

Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	27-800-3	Core Boxes	Soluble Oil
Angle	-83°	Cement	Drill Mud
Depth, End	408	Fondu	Rod Lube
Depth, Begin.	258	Grout Packer	Size
Drilled	150	Mech Packer	Size
Core Removed	150	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2211-07	NEW BITS	238		
REAMING SHELLS					
BW-44	P-1270	1822	0		

Remarks (Explain Delays) HOLE DOESN'T SEEM TO be MAKING ANY WATER YET!

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 21
Mine Project: Lamefoot Date 11-11-97
Location 2225 Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW 44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	27-800-3	Core Boxes	Soluble Oil
Angle	-83°	Cement	Drill Mud
Depth, End	468	Fondu	Rod Lube
Depth, Begin.	408	Grout Packer	Size
Drilled	60	Mech Packer	Size
Core Removed	60	Lost Circulation	
# of Runs		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	4	Cementing	
Reaming		Equip. Repair	3 - Remarks
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW 44	7-2211-7	New BITS	238'		

REAMING SHELLS

BW 44	P-1270	1822'	0		

Remarks (Explain Delays) Seal in Rotation Drive motor Blew, Filling Head up with Hyd. Oil. Hole making 10 gal min of water @ 450'

Driller C. Jess Helper K. Dalbaten

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 21
Mine Project: LameFoot Date 11-12-97
Location 2225 Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	27-800-3	Core Boxes	Soluble Oil
Angle	-83°	Cement	Drill Mud
Depth, End	588	Fondu	Rod Lube
Depth, Begin.	468	Grout Packer	Size
Drilled	120	Mech Packer	Size
Core Removed	120	Lost Circulation	
# of Runs		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	9	Cementing	
Reaming		Equip. Repair	1 - put Head togeth
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2211-7	new BITS	238		
		REAMING SHELLS			
BW44	P-1270	1822'	0		

Remarks (Explain Delays) Hole marking 20 gal. min water
? 10gpm. at T.D.

Driller C. Jess Helper K. DalBaleon

Approved by Client

DYNAMIC DRILL

SHIFT REPORT

Client: Edna Bay Job No. 21

Main Project: Lambert T. Date: 11-12-17

Location: [illegible] Shift: Day Shift Hrs: 12 Equip: [illegible]

Hole Size: NTW N B2 [illegible] A Other:

HOLE INFO	SUPPLIES
Hole #: 20-R00-3	Core Boxes: ____ Smoke On: ____
Angle: -83°	Cement: ____ Drill Mud: ____
Casing Size: BQ	Resin: ____ Rod Lube: ____
Depth Casing: 113.5	Grout Packer: ____ Size: ____
Drilled: 120	Mech Packer: ____ Size: ____
Core Recovered: 120	Loss Circulation: ____
# of Trips: ____	
	Other: ____

Feet Drilled: ____ From: ____ To: ____

Feet Cored: ____ From: ____ To: ____ Size: ____ Core: ____

Barren Ground: ____ From: ____ To: ____

TIME CHANGES (Hours)

Drilling	9	Cementing	
Reaming		Equip. Repair	1 - Repaired [illegible]
Coring		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Misc. Delay	
Survey		Other Delay	
Other (Travel)			

Size	Size Inc.	Previous Footage	On	Off	Total Footage
BQ	7-3/4-7	1,861	Drill 2:23		

REAMING SHEETS

Core	5-1/2	1,862	5

Reaming (Down Delay): Hole Opening - Sample Prep

Comments: [illegible]

Driller: [illegible] Helper: [illegible]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAME FOOT Date 11-13-97
Location 2225 Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	27-800-3	Core Boxes	
Angle	-83°	Cement	
Depth, End	598 T.D.	Fondu	
Depth, Begin.	588	Grout Packer	Size
Drilled	10	Mech Packer	Size
Core Removed	10	Lost Circulation	
# of Runs		Other	
		Soluble Oil	
		Drill Mud	
		Rod Lube	

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	2	Cementing	
Reaming		Equip. Repair	2
Casing		Delays by Client	
Setup, Tear Down	3 - STATION MOVE	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	1 - REMOVE + REPLACE PACKE
Other (Specify)	2 - MOVE ELECTRIC box + CABLE		

	Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS	BW-44	7-2211-7	NEW	238	588	250 STILL GOOD
REAMING SHELLS	BW-44	P-1270	1822	0	588	2410 STILL GOOD

Remarks (Explain Delays) HOLE IS MAKING 10 G.P.M. EXACTLY. REPLACE BROKEN bolts IN ROD HOLDER + BUSHINGS IN ROTATION UNIT CARRIER. CHANGED OIL IN ROTATION UNIT.

Driller K. DECKER Helper J. OSLER

Approved by Client

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO BAY Job No. 21

Project: LAME FOOT Date 11-5-97

Location _____ Shift: Day ✓ Swing ____ Grvyd ____

Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #		Core Boxes	Soluble Oil
Angle		Cement	Drill Mud
Depth, End		Fondu	Rod Lube
Depth, Begin.		Grout Packer	Size
Drilled		Mech Packer	Size
Core Removed		Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling		Cementing	
Reaming		Equip. Repair	
Tripping		Delays by Client	
Setup, Tear Down	8	Delays by Contractor	
Hole Conditioning		Blast Delay	
~~Survey~~	NO CHARGE ✓	Other Delay	1-SAFETY MEETING

Other (Specify) 1-HR WAIT ON ELECTRICIAN SPLICE CABLE

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
REAMING SHELLS					

Remarks (Explain Delays) JAE 2 HRS. HAD ELECTRICIAN SPLICE POWER CABLE

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 21
Project: LamEfoot — Date 10-29-97
Location: 2225 — Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW 44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	2225-77-900-1	Core Boxes	Soluble Oil
Angle	-20°	Cement	Drill Mud
Depth, End	48	Fondu	Rod Lube
Depth, Begin.	0	Grout Packer	Size
Drilled	48	Mech Packer	Size
Core Removed	48	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	2	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	8	Delays by Contractor	
Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2211-05	135' BITS	0		

REAMING SHELLS

Remarks (Explain Delays): Station move. move everything & Set up

Driller: C. Jess — Helper: K. DalBalem

Approved by Client: [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO BAY Job No. 21
Project: LAME FOOT Date 10-30-97
Location 2225 Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO

Hole # 27-900-1
Angle -20°
Depth, End 228
Depth, Begin. 48
Drilled 180
Core Removed 180
# of Runs ____

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 9 1/2
Reaming ____
Casing ____
Setup, Tear Down ____
Hole Conditioning ____
Survey ____
Cementing ____
Equip. Repair ____
Delays by Client ____
Delays by Contractor ____
Blast Delay ____
Other Delay ____
Other (Specify) 1/2- POWER KICKED OFF

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	L-91908 BIT TEST	80	58	178	200 T
BW-44	7-2211-05	193	178		

REAMING SHELLS

BW-44	P-3003	1867	0		

Remarks (Explain Delays) HOLE ISNT MAKING ANY WATER AT 228 HOLE IS 40" From Sill to Collar

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client Echo Bay Job No. 21
Site Project: Lone Foot Date 10-30-97
Location 2225 Shift: Day ___ Swing X Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO

Hole # 27-900-1 / 900-2
Angle -30 -40
Depth, End 388
Depth, Begin. 228
Drilled 160
Core Removed 160
# of Runs ___

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 8
Reaming ___
Casing ___
Trip Tear Down 1
Hole Conditioning ___
Survey ___
Other (Specify) 1/2 Power Kicked off

Cementing ___
Equip. Repair 1/2 Asust Feed Chain
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ___

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW44	7-2211-05	193	BITS	178	388	403' Good

REAMING SHELLS

BW44	P-3003	1867	0	388	2255'

Remarks (Explain Delays) Hole making 1 gal per min.
@ 360'

Driller C. Jess Helper K- Dal Bulem
Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Project: LAME FOOT Date 10-31-97
Location 2225 Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW-44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	27-900-2	Core Boxes	Soluble Oil
Angle	-40°	Cement	Drill Mud
Depth, End	217	Fondu	Rod Lube
Depth, Begin.	0	Grout Packer	Size
Drilled	217	Mech Packer	Size
Core Removed	217	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Rig, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2211-05	[redacted]403 BITS	0	38	441T
BW-44	L-89870	NEW	0		
		REAMING SHELLS			
BW-44	P-1270	NEW	0		

Remarks (Explain Delays) COLLAR TO SILL IS 3 FT. ON HOLE # 27-900-1 + 16 IN. ON HOLE # 27-900-2
HOLE #2 ISN'T MAKING ANY WATER AT 217'

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 21
Mine Project: Lombkoot — Date 10-31-97
Location 2225 — Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO

Hole # 27-900-2
Angle -40°
Depth, End 403
Depth, Begin. 217
Drilled 186
Core Removed 186
# of Runs

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 10
Reaming
Casing
Set up, Tear Down
Hole Conditioning
Survey
Other (Specify)

Cementing
Equip. Repair
Delays by Client
Delays by Contractor
Blast Delay
Other Delay

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	L89870	New	38'	332'	294 T
BW44	7-2212/03	New	332'		

REAMING SHELLS

344	P-1270	New	0		

Remarks (Explain Delays) Hole making 2 gal per min. water @ 400'

Driller C. Jess — Helper K. Dal Bulem

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Project: LAME FOOT Date 11-3-97
Location 2225 Shift: Day ✓ Swing ____ Grvyd. ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44/A ____ Other ____

HOLE INFO

Hole # 27-900-2
Angle ____
Depth, End 423 T.D.
Depth, Begin. 403
Drilled 20
Core Removed 20
# of Runs ____

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 2
Reaming ____
Casing ____
Setup, Tear Down 2
Hole Conditioning ____
Survey ____
Other (Specify) 1/2 TRUCK BROKE DOWN ON RAMP

Cementing ____
Equip. Repair 5 1/2
Delays by Client ____
Delays by Contractor ____
Blast Delay ____
Other Delay ____

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2211-03	NEW	332	423	91 Still Good

REAMING SHELLS

BW-44	P-1270	NEW	0	423	423 Still Good

Remarks (Explain Delays) COLLAR TO SILL IS RIGHT AT THE SILL ON HOLE # 27-900-3
~~[illegible]~~ Rebuilt ROD HOLDER VALVE & HAD TO GO OUT AND HAVE Hyd. HOSE MADE.

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client Echo Bay Job No. 21
Project: LAMEFOOT Date 11-3-97
Location 2225 Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW 44 A ___ Other ___

HOLE INFO

Hole # 27-900-3
Angle -60°
Depth, End 258
Depth, Begin. 0
Drilled 258
Core Removed 258
# of Runs ___

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 10
Reaming ___
Casing ___
Setup, Tear Down ___
Conditioning ___
Survey ___
Other (Specify) ___

Cementing ___
Equip. Repair ___
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
3044	7-2711-3	91' ~~NEW~~ BITS	0	228'	319' T
3044	7-2315-1	new	228'		
		REAMING SHELLS			
3044	P-1270	423	0		

Remarks (Explain Delays) ___

Driller C. Jess Helper K. Dolbalem

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO BAY Job No. 21
Mine Project: LAMEFOOT Date 11-4-97
Location Shift: Day ✓ Swing Grvyd
Hole Size: HQ NTW NQ BW-44 A Other

HOLE INFO		SUPPLIES	
Hole #	27-900-3	Core Boxes	Soluble Oil
Angle	-60°	Cement	Drill Mud
Depth, End	428	Fondu	Rod Lube
Depth, Begin.	258	Grout Packer	Size
Drilled	170	Mech Packer	Size
Core Removed	170	Lost Circulation	
# of Runs		Other	

Feet Reamed From To
Feet Cased From To Size C/S #
Cement Drilled From To

TIME CHARGES (Hours)

Drilling 9 Cementing
Reaming Equip. Repair 1- ROD HOLDER VALVE
Casing Delays by Client
Setup, Tear Down Delays by Contractor
Hole Conditioning Blast Delay
Delay Other Delay
Other (Specify)

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2315-1	NEW BITS	228		

REAMING SHELLS

BW-44	P-1270	423			

Remarks (Explain Delays) 10.0 GAL. DIESEL. HOLE IS MAKING ABOUT 1½ TO 2 GPM OF WATER

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client Echo Bay Job No. 21
Project: LAMEFOOT Date 11-4-97
Location 2225 Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW 44 A ___ Other ___

HOLE INFO

Hole # 27-900-3
Angle -60°
Depth, End 498
Depth, Begin. 428
Drilled 70
Core Removed 70
# of Runs ___

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 5
Reaming ___
Casing ___
Tear Down 5 station move
Hole Conditioning ___
Survey ___
Other (Specify) ___
Cementing ___
Equip. Repair ___
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2315-1	NEW BITS	228	498	270' still good
REAMING SHELLS					
BW44	P-1270	423	0	498	921'

Remarks (Explain Delays) Hole making 5 gal per min. water station move - almost everything moved 50% left

Driller C. Jess Helper K. Dal Balsam

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO-BAY Job No. 21-2
Mine Project: Lamefoot Date 10-20-97
Location Republic, WA. Shift: Day ___ Swing ___ Grvyd ✓
Hole Size: HQ ___ NTW ___ NQ ___ BW 44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	28-000-4	Core Boxes	Soluble Oil
Angle	-65°	Cement	Drill Mud
Depth, End	218'	Fondu	Rod Lube
Depth, Begin.	83'	Grout Packer	Size
Drilled	135'	Mech Packer	Size
Core Removed	135	Lost Circulation	
# of Runs		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	9½	Cementing	
Reaming		Equip. Repair	½
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage		On	Off	Total Footage
Bw44	7-2016-04	new	BITS	35	200	165'
11 11	L-89865	New		200		
			REAMING SHELLS			
11 11	P.3003	225		0		

Remarks (Explain Delays) 8.0 Fueled Kubota.
½ hr Had to take in Tub Head to shop, so I could rethed greas zerk Thead.

Driller M. Lutz Helper K. dalbalcon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAMEFOOT Date 10-20-97
Location: Republic Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-000-4	Core Boxes	
Angle	-65°	Cement	
Depth, End	83	Fondu	
Depth, Begin.	0	Grout Packer	Size
Drilled	83	Mech Packer	Size
Core Removed	83	Lost Circulation	
# of Runs		Other	

Soluble Oil ____
Drill Mud ____
Rod Lube ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	6	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	4	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) ____

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2017-06	225	0	35	260T
BW-44	7-2016-04	NEW	35		

BITS

REAMING SHELLS

BW-44	P-3003	225	0		

Remarks (Explain Delays) HOLE IS COLLARED RIGHT AT THE SILL; ALSO NOT MAKING ANY WATER AT 83' SO FAR

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

Client: ECHO BAY
Job No. 21
Mine Project: LAMEFOOT
Date 10-21-97
Location
Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO

Hole # 28-000-4
Angle -65°
Depth, End 358 T.D.
Depth, Begin. 218
Drilled 140
Core Removed 140
# of Runs

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 8 1/2
Reaming
Casing
Setup, Tear Down 1 1/2
Hole Conditioning
Survey
Other (Specify)

Cementing
Equip. Repair
Delays by Client
Delays by Contractor
Blast Delay
Other Delay

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	L-89865	NEW	200	358	158 ST.

REAMING SHELLS

BW-44	P-3003	225	0	358	583

Remarks (Explain Delays) CHANGED OIL IN ROTATION UNI
HOLE #28-000-4 NOT MAKING ANY WATER
AT 358'.

Driller K. DECKER
Helper J. OSLER
Approved by Client

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAMEFOOT Date: 10-6-97
Location: Republic Zone Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO		Renter
Hole #	28-200-3	& 2
Angle	-79	-57
Depth, End	353	340
Depth, Begin.	313	333
Drilled	40	7
Core Removed	40	9
# of Runs		

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 4½ HR
Reaming ___
Casing ½ HR PULL CASING
Setup, Tear Down ___
Conditioning ___
Survey ___
Other (Specify) 3HR RENTER HOLE #28-200-2

Cementing ___
Equip. Repair 1½ HR
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ½ HR SET GROUT PLUG

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW44	7-2017/04	New	125	353	228
"	"	228	333	340	DEAD 235
"	158395	New	340		
REAMING SHELLS					
BW44	05288	1589	0	353	1942
"	"	1942	0		

Remarks (Explain Delays) Broke Fitting on Rod Holder WAIT For Ride out

Driller HELLMAN Helper OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO-BAY Job No. 21-2

Mine Project: Lamefoot Date 10-6-97

Location Republic Shift: Day ____ Swing ____ Grvyd X

Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-200-2	Core Boxes	Soluble Oil
Angle	-57°	Cement	Drill Mud
Depth, End	438' T.D	Fondu	Rod Lube
Depth, Begin.	340'	Grout Packer	Size
Drilled	98	Mech Packer	Size
Core Removed	98	Lost Circulation	
# of Runs		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	8 1/2	Cementing	
Reaming	1/2 remarks	Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	1 reInter	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	BITS On	Off	Total Footage
BW44L	88395	new	340	438	98
" "	" " "	98			

REAMING SHELLS

BW44	05288	1942	333	438	2387

Remarks (Explain Delays) 11.2 Fuel From 10-4-97. realigh drill To Hole # 2, got down To 325' Had To ream To Bottem.

Driller M. LUTZ Helper K. dalbalcon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 21
Project: B Lamefoot Date 12-3-97
Location 2225 Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ B 1044 A ___ Other ___

HOLE INFO		
Hole #	28-300-5	28-200-4
Angle	-43°	-27
Depth, End	423	124
Depth, Begin.	363	0
Drilled	60	124
Core Removed	60	124
# of Runs		

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 8.5 Cementing ___
Reaming ___ Equip. Repair ___
Casing ___ Delays by Client ___
Tear Down 1 1/2 - Delays by Contractor ___
Hole Conditioning ___ Blast Delay ___
Survey ___ Other Delay ___
Other (Specify) ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2548-2	New BITS	363	403	40' T
BW-44	7-2212-10	New	403	423	20'
"	"	20	0		
REAMING SHELLS					
BW-44	P-1270	5960	0	423'	
"	"	6383	0		

Remarks (Explain Delays) #200-4 is 3' From collar to Sill / Change Oil in Hand

Cyfess Helper K. Del Balcon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 21
Project: Lamefoot — Date 12-4-97
Location: 2225 — Shift: Day ____ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW 44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	280-200-4 / 28-200-5	Core Boxes	Soluble Oil
Angle	-27° / -48°	Cement	Drill Mud
Depth, End	339 / 89	Fondu	Rod Lube
Depth, Begin.	124 / 0	Grout Packer	Size
Drilled	215 / 89	Mech Packer	Size
Core Removed	215 / 89	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	9	Cementing	
Reaming		Equip. Repair	
Coring		Delays by Client	
Set Up / Tear Down	1	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2212-10	20'	0	270'	290' T
	7-2212-11	New	270'	339	69'
	"	69	0		
REAMING SHELLS					
BW44	P-1270	6383	0	339	6732'
	"	6732	0		

Remarks (Explain Delays): Hole # 200-4 Not making any water / Hole 200-5 1' from collar to sill & No water

C. Jess — Helper K. DelBalcom

Approved by Client: [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 21
Mine Project: Lomekoot Date 12-5-97
Location 2225 Shift: Day ___ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW-44 A ___ Other ___

HOLE INFO

Hole # 28-200-5
Angle -48°
Depth, End 261
Depth, Begin. 89
Drilled 172
Core Removed 172
# of Runs ___

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 9 Cementing ___
Reaming ___ Equip. Repair 1 - Rod Holder
Casing ___ Delays by Client ___
Set Up, Tear Down ___ Delays by Contractor ___
Hole Conditioning ___ Blast Delay ___
Survey ___ Other Delay ___
Other (Specify) ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2212-11	69	0	99	168' T
"	P 1304	New	99	237	138 still Good
	7-2470-4	New	237		
		REAMING SHELLS			
	P-1270	6732	0		

BITS

Remarks (Explain Delays) Hole making @ 1 gal min of water. Hard & Broken Rock 220' - 260'

Driller C. Jess Helper K. Del Belcom

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Exxon Corp. Job No. 321
Contractor: Arctic Oil Field: 12S-S-72
Rig No. 2 Shift Date: Shift: Day
Elevation: KBM: MD: RKB-MSL: Other:

HOLE INFO	SUPPLIES
Hole: 8½-2 Jets-5	Core Boxes: Solution Oil:
Mode: Lg B	Cement: Drill Mud:
Depth End: 8,11	Fuel: Rod Lube:
Depth Begin: 8,9	Drill Pipe: Bit:
Bit No: 1-3-7	Mech Feeder: Bit:
Bits Diamond: 1 22	Lubr Grease:
# of Hole:	
	Other:

Total Time: From: To:
Total Cores: From: To: Dia: O.S.
Cement Drilled: From: To:

TIME CHARGES (Hours)

Drilling: 9 Circulating:
Reaming: Wait For: 1 - Fuel Delivery
Coring: Delays by Client:
Wait for Core: Delays by Contractor:
Hole Conditions: Rig in Delay:
Survey: Other Delay:
Other Equipment:

Bits	Size	Hours	Previous Footage	On	Off	Total Footage
Diamond	7-7/12-11	6.9	Bits	0	6.9	168.7
Jet	9 1/2H	4.4		99	237	138.8
	7-7/8 X-V	AVG	237			

REAMING SHEETS

9-1/2H	6.732	0	

Remarks (Below): Hole Washing @ 1 gal/min
Set 1/2 Jets
Pipe - 2.0

Driller: K. Robertson

Approved by Client:

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 27
Mine Project: Lomefoot Date 12-7-97
Location 2225 Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ B ____ A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #		Core Boxes	Soluble Oil
Angle		Cement	Drill Mud
Depth, End		Fondu	Rod Lube
Depth, Begin.		Grout Packer	Size
Drilled		Mech Packer	Size
Core Removed		Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling		Cementing	
Reaming		Equip. Repair	5 1/2
Casing		Delays by Client	
Set Up, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) ____

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
REAMING SHELLS					

Remarks (Explain Delays) Change out Front Seal in Rotation unit

Driller C. Jess / JD Helper ____

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Job No. 21

Date 12-7-77

Shift Day Evening Night

Hole Size No. NTW NQ B K Other

HOLE INFO

Hole #

Angle

Depth End

Depth Begin

Core

Core Recovery

# of Runs

SUPPLIES

Core Boxes Sawing Oil

Cement Drill Mud

Rinsin Food Juice

Grout Pipe Size

Mesh Pipe Size

Last Circulation

Other

Fuel Used Prior To

Fuel Used From To Size Cost

Drilling Hours From To

TIME CHARGED (Hours)

Drilling Cementing

Reaming Setup Repair

Coring Delays by Client

Trip Down Delays by Contractor

Hole Cleaning Delays

Survey Other Delays

Other (Specify)

BITS

Size	Serial No.	Footage	On	Off	Total Footage

REAMING SHELLS

Remarks (Also on back)

Called to Foreman Cost Foot

Signature

Reviewed by Date

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Project: LAME FOOT Date 12-8-97
Location 2225 Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		SUPPLIES			
Hole #	28-200-5	Core Boxes		Soluble Oil	
Angle	-48°	Cement		Drill Mud	
Depth, End	284	Fondu		Rod Lube	
Depth, Begin.	261	Grout Packer		Size	
Drilled	23	Mech Packer		Size	
Core Removed	23	Lost Circulation			
# of Runs					
		Other			

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	2	Cementing	
Reaming		Equip. Repair	8
Casing		Delays by Client	
Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) ____

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2470-4	NEW	237		

REAMING SHELLS

BW-44	P-1270	6732	0		

Remarks (Explain Delays) 8-HRS. ROD HOLDER NOT WORKING PROPERLY. GRIPS SOMETIMES THEN IT DOESN'T.

HOLE MAKING 1 GPM OF WATER AT 284'

Driller K. DECKER Helper J. OSLER - 7 HRS.

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 21

Mine Project: Lamefoot — Date 12-8-97

Location 2225 — Shift: Day ___ Swing ✓ Grvyd ___

Hole Size: HQ ___ NTW ___ NQ ___ BW-44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	28-200-5	Core Boxes	Soluble Oil
Angle	-48°	Cement	Drill Mud
Depth, End	427	Fondu	Rod Lube
Depth, Begin.	284	Grout Packer	Size
Drilled	143	Mech Packer	Size
Core Removed	143	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ___ From ___ To ___

Feet Cased ___ From ___ To ___ Size ___ C/S # ___

Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Trip, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2470-4	new	237	358	121' T
n	7-2470-5	new	358	368	10' T
n	7-2212-12	new	368		

BITS

REAMING SHELLS

n	P-1270	6732'			

Remarks (Explain Delays) Hard-Broken Rock all note Hole making 1 gal min water.

Driller C. Jess — Helper K. DelBoskerm

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Exxon Corp. Job No. 21

Project: Lease Sec 1 Date: 12-8-92

Rig: 2335 Shift: Day Swing Night

Mob/Demob: MW MO BK-HA Other

HOLE INFO	SUPPLIES
Hole # 2B-200-3	Core Barrel Daily Oil
Angle -90°	Cement Drill Rod
Depth End 427	Grade Pipe Dope
Depth Begin 384	Donut Packer Bits
Drilled 43	Mech Packer Bits
Core Removed 143	Lost Circulation
# of Runs	
	Other

Pipe Reamed From To

Pipe Cored From To Bit Core #

Cement Drilled From To

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Coring		Delays by Client	
Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify)

Size	Serial No	Previous Footage	On	Off	Total Footage
Bit	7-2U-24	4W3	327	358	131'
Bit	7-2U-5	N4D3	358	366	18'
Bit	7-2-12-4	N4D3	366		

REAMING SHELLS

24"	0-120	0-132'

Remarks (Explain Delay) Hole 2B-200-3 Hit at 384' Cut 43'

Lost Core Hole 2B-200-3 Cut 143' in at 384'

Driller [signature] Helper K. Dalessandro

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO BAY Job No. 21

Mine Project: LAMEFOOT Date 12-9-97

Location _____ Shift: Day ✓ Swing ____ Grvyd ____

Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-200-5	Core Boxes	Soluble Oil
Angle	-48°	Cement	Drill Mud
Depth, End	478 TD	Fondu	Rod Lube
Depth, Begin.	427	Grout Packer	Size
Drilled	51	Mech Packer	Size
Core Removed	51	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	4	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	3- LEVEL MOVE to 2420	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) 3HR. WAITING ON 2420 To be CLEANED OUT

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2212-12	NEW	BITS 368	478	110 STILL GOOD
		REAMING SHELLS			
BW-44	P-1270	6732	[illegible]0	478	7210

Remarks (Explain Delays) HOLE MAKING About 2 GPM OF WATER AT 450"

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client _____ Job No. _____

Operator _____ Date _____

Contractor _____ Shift Day ___ Swing ___ Time ___

Hole Size HO ___ NTW ___ HO ___ BQ/NQ/A ___ Other ___

HOLE INFO

Hole # _____

Angle _____

Depth End _____

Depth Begin _____

Drilled _____

Core Recovered _____

# of Runs _____

SUPPLIES

Core Boxes ___ Sample Cr ___

Casing ___ Grp Mat ___

Feed ___ Rev Line ___

Bond Rader ___ Bit ___

Mech Rader ___ Size ___

Lost Circulation _____

_____

Other _____

Rod Pulled _____ From ___ To ___

Rod Cased _____ From ___ To ___ Size ___ Cost ___

Casing Drilled _____ From ___ To ___

TIME CHARGES (Hours)

Drilling _____ Commuting _____

Reaming _____ Equip. Repair _____

_____ Delays by Client _____

_____ Delays by Contractor _____

Hole Conditioning _____ Bad Days _____

Survey _____ Other Delay _____

Other (Specify) _____

Size	Serial No.	Previous Footage	On	Off	Total Footage

REAMING BITS

Size	Serial No.	On	Off	Total Footage

Remarks (Explain Delays) _____

_____

_____

_____

_____

_____

Driller _____

Approved by Client _____

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 21
Project: Lamefoot Date 12-9-97
Location 2420 Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW 44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #		Core Boxes	Soluble Oil
Angle		Cement	Drill Mud
Depth, End		Fondu	Rod Lube
Depth, Begin.		Grout Packer	Size
Drilled		Mech Packer	Size
Core Removed		Lost Circulation	
# of Runs		Other 9.6 gal Desel	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling		Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Set, Tear Down	10-4 wet move	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
REAMING SHELLS					

Remarks (Explain Delays) move from 2225 to 2420'
Changed Oil in Rotation!

Driller ___ Helper ___
Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

#2

Client ECHO-BAY Job No. 21-2
Mine Project: Lamefoot Date 9-26
Location Republic, WA. Shift: Day ____ Swing ____ Grvyd X
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-300-1 / 28-200-1	Core Boxes	
Angle	-35° / -40	Cement	
Depth, End	406 / 48	Fondu	
Depth, Begin.	366 / -0-	Grout Packer	Size
Drilled	40 / 48	Mech Packer	Size
Core Removed	40 / 48	Lost Circulation	
# of Runs		Other	

Soluble Oil ____ Drill Mud ____ Rod Lube ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	8½	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	1	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)	½ Packer		

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2017-01	New	198	406	208
" "	" " "	208	0		

REAMING SHELLS

BW44	05288	850	0	406	1256
" "	" " "	1256			

Remarks (Explain Delays)

Driller M. Lutz Helper K. dal Balcon

Approved by Client RW Lee

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21-2
Mine Project: LAMEFOOT Date 9-29-99
Location: Republic wa Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-200-1	Core Boxes	
Angle	-40	Cement	
Depth, End	233	Fondu	
Depth, Begin.	48	Grout Packer	Size
Drilled	185	Mech Packer	Size
Core Removed	185	Lost Circulation	
# of Runs		Other	

Soluble Oil ____ Drill Mud ____ Rod Lube ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	9Hr	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	1Hr No Power
Other (Specify)			

Remarks

Size	Serial No.	Previous Footage	BITS	On	Off	Total Footage
BW44	720176/01	208		0	91	299
"	288392	New		91		

REAMING SHELLS

BW44	05288	1256			

Remarks (Explain Delays)
COLLAR TO SILL #28-200-1 - 2'8"
WATER AT 130' MORE AT 230'
PLUG BURNED UP ON POWER UNIT

Driller HELLMAN Helper OSLEN

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO-BAY Job No. 21-2
Mine Project: Lamefoot Date 9-29-97
Location Republic Shift: Day ____ Swing ____ Grvyd X
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-200-1	Core Boxes	
Angle	-40	Cement	
Depth, End	343 333	Fondu	
Depth, Begin	233	Grout Packer	Size
Drilled	100 (110)	Mech Packer	Size
Core Removed	99	Lost Circulation	
# of Runs			
		Other	

Soluble Oil ____ Drill Mud ____ Rod Lube ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	9.5	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) 1/2 SUPPLY STAKE BOXES TO LAY DOWN

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
Bw44	L88392	NEW	91	318	227
" "	7-2017/03	NEW	318		

REAMING SHELLS

Bw44	05288	1256			

Remarks (Explain Delays) Hole STARTED MAKING MORE WATER AT 288!

Driller M. LUTZ Helper K. dal balcon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAMEFOOT Date 9-30-97
Location: Republic Wa Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ B W44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-200-1 / 2	Core Boxes	Soluble Oil
Angle	-40 / -57	Cement	Drill Mud
Depth, End	380	Fondu	Rod Lube
Depth, Begin.	343 / 0	Grout Packer	Size
Drilled	37	Mech Packer	Size
Core Removed	37	Lost Circulation	
# of Runs		Other	

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	5 Hr	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	1½ Hr Remarks
Setup, Tear Down	2½ Hr	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	1 Hr Install Grout Packers 2
Other (Specify)			

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2017/03	New	318	360	Dead 42
"	P1301	New	360	380	20
"	"	20			

REAMING SHELLS

BW44	05288	1256	0		

Remarks (Explain Delays) Hole # 28-200-1 IS MAKING 20 gal P.M. H20.
Air Line WAS FULL OF WATER & RUST
Pluged oiler Air Hoses & JACKLEG
(you need to blow air line before using!)

Driller HELLMAN Helper OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO-BAY Job No. 21-2
Mine Project: Lamefoot Date 9-30-97
Location: Republic Shift: Day ____ Swing ____ Grvyd X
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO

Hole # 28-200-2
Angle -57°
Depth, End 103
Depth, Begin. -0-
Drilled 103
Core Removed 103
# of Runs ____

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 8.½
Reaming ____
Casing ____
Setup, Tear Down ½
Hole Conditioning ____
Survey ____
Other (Specify) ½ supplys

Cementing ____
Equip. Repair ½
Delays by Client ____
Delays by Contractor ____
Blast Delay ____
Other Delay ____

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
~~BW44~~	~~7-2017~~				
" "	P1301	20	0	93	113
" "	7-2016/03	NEW	93		
REAMING SHELLS					
BW44	05288	1256	0		

Remarks (Explain Delays) broke water Hose, 10.0 Gal. fuel in Kubota.

Driller M. LUTZ Helper Kydal balcon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client _____ Job No. _____

Main Project _____ Date _____

Rig _____ Shift Date _____ Shift _____ Driller _____

Hole No. _____ NTW _____ NQ _____ Size _____ Other _____

HOLE INFO		SUPPLIES	
Hole _____	Core Barrel _____	Bailing Oil _____
Angle _____	Casing _____	Drill Mud _____
Depth End _____	Points _____	Pipe Lube _____
Depth Begin _____	Crown Reamer _____	Size _____
Drilled _____	Bottom Reamer _____	Size _____
Core Removal _____	Total Circulation _____	
# of Runs _____		
	Other _____	

Fuel Received _____ From _____ To _____

Fuel Used _____ From _____ To _____ Size _____ Cost $ _____

Current Total _____ From _____ To _____

TIME CHANGES (Hours)	
Drilling _____	Cementing _____
Reaming _____	Equip. Repair _____
Coring _____	Delays by Client _____
Pull Tee Down _____	Delays by Contractor _____
Condition _____	Blast Delay _____
Survey _____	Other Delay _____
Other (Specify) _____	

Size	No.	Previous Footage	On	Off	Total Footage
		BITS			

		REAMING BITS	

Remarks (Include Delays) _____ Lost Time & Other Notes _____

Logged by _____ Helper _____

Approved by Client _____

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO BAY Job No. 21

Mine Project: LAMEFOOT Date 10-1-97

Location Republic Wa Shift: Day ✓ Swing ____ Grvyd ____

Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-200-2	Core Boxes	Soluble Oil
Angle	-57	Cement	Drill Mud
Depth, End	273	Fondu	Rod Lube
Depth, Begin.	103	Grout Packer	Size
Drilled	170	Mech Packer	Size
Core Removed	170	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10HR	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2016/03	New BITS	93	203	Dead 110
"	L88393	New	203		

REAMING SHELLS

BW44	05288	1256	0		

Remarks (Explain Delays) COLLAR TO SILL # 28-200-2 ~ 1'. Hole #2 IS MAKING 20 gal P.M. H2O. AT 170'

Driller HELLMAN Helper OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAMEFOOT Date 10-2-97
Location: Republic wa Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-200-2	Core Boxes	
Angle	-57	Cement	
Depth, End	333	Fondu	
Depth, Begin.	273	Grout Packer	Size
Drilled	60	Mech Packer	Size
Core Removed	60	Lost Circulation	
# of Runs		Other	

Soluble Oil ____ Drill Mud ____ Rod Lube ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	7 HR	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	2½ HR	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	½ HR IN STALL PACKER
Other (Specify)	1 HR SUPPLYS		

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW44	L88393	New	203	333	130
"	"	130	0		
REAMING SHELLS					
BW44	05288	1256	0	333	1589
"	"	1589	0		

Remarks (Explain Delays)

Driller HELLMAN Helper OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO-BAY Job No. 21-2
Mine Project: LAMEFOOT Date 10-2-97
Location: RePublic, WA Shift: Day ____ Swing ____ Grvyd X
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-200-3	Core Boxes	
Angle	-79°	Cement	
Depth, End	56	Fondu	
Depth, Begin.	-0-	Grout Packer	Size
Drilled	56	Mech Packer	Size
Core Removed	56	Lost Circulation	
# of Runs		Other	

Soluble Oil ____ Drill Mud ____ Rod Lube ____

Feet Reamed 5 From 0 To 5
Feet Cased 5 From 0 To 5 Size NQ C/S #
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	7	Cementing	
Reaming		Equip. Repair	
Casing	1 1/2 hrs	Delays by Client	
Setup, Tear Down	1 hr	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) 1/2 Had TO DRAIN AIR LINE.

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	288393	130	0		

BITS

REAMING SHELLS

11 11	05288	1589	0		

Remarks (Explain Delays)
Had tough time getting thru silt & "Muck" to good Hard rock.

Driller M. LUTZ Helper K. dalbakon

Approved by Client [signature]

DYNAMIC DRILLING
DAILY REPORT

Town _____ Job No. _____

Site Project _____ Date _____

Start Date _____ Start Day _____ Shift _____

Rig Type No. _____ ATM _____ No. _____ Size _____ Open _____

HOLE DATA

Hole _____

Angle _____

Depth End _____

Depth Begin _____

Drilled _____

Core Recovered _____

% of Run _____

SUPPLIES

Core Boxes _____ Radio Oil _____

Cement _____ Oil Mix _____

Frac'ed _____ Red Lube _____

Drill Pipe _____ Bit _____

Mech Packer _____ Size _____

Total Circulation _____

_____

Other _____

Rod Reamed _____ From _____ To _____

Pipe Cased _____ From _____ To _____ Size _____ Date _____

Cement Drilled _____ From _____ To _____

TIME CHARGES (Hours)

Drilling _____ Cementing _____

Reaming _____ Equip. Repair _____

Coring _____ Delays by Client _____

Trip Down _____ Delays by Contractor _____

Reconditioning _____ Rest Day _____

Survey _____ Other Delay _____

Other (Specify) _____

Bit	Depth	Previous Footage	On	Off	Total Footage
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

REAMING SHELLS

_____ _____ _____ _____

_____ _____ _____ _____

Remarks (Explain Delays)

_____

_____

_____

_____

_____

_____

Driller _____ Helper _____

Approved by Client _____

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO BAY Job No. 21

Mine Project: LAME FOOT Date 10-3-97

Location Republic wa Shift: Day ✓ Swing ____ Grvyd ____

Hole Size: HQ ____ NTW ____ NQ ____ B W44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-200-3	Core Boxes	Soluble Oil
Angle	-79	Cement	Drill Mud
Depth, End	163	Fondu	Rod Lube
Depth, Begin.	56	Grout Packer	Size
Drilled	107	Mech Packer	Size
Core Removed	107	Lost Circulation	
# of Runs		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10 Hr	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
Bw44	L88393	130 BITS	0	125	Dead 255
"	7-2017/04	New	125		

REAMING SHELLS

Bw44	05288	1589	0		

Remarks (Explain Delays) Collar to Sill # 28-200-3 - IN Floor

Driller HellMAN Helper Osler

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO-BAY Job No. 21-2
Mine Project: LAMEFOOT Date 10-3-97
Location: Republic, WA Shift: Day ____ Swing ____ Grvyd ✓
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-200-3	Core Boxes	
Angle	-79°	Cement	
Depth, End	263'	Fondu	
Depth, Begin.	163'	Grout Packer	Size
Drilled	100'	Mech Packer	Size
Core Removed	100'	Lost Circulation	
# of Runs		Other	

Soluble Oil ____ Drill Mud ____ Rod Lube ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	5½	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	4½ hrs No Power
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)	½ hr moved Elect. unit away from water (part of no power time)		

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2017/64	New	125		

REAMING SHELLS

BW44	05288	1589	0		

Remarks (Explain Delays)
4 hours lost power. water was rising had to move power unit!
Hole started making water about 20 gal. P.M AT 183'.
Kevin dalbalcon 6½ hrs

Driller M. LUTZ Helper K. dalbacon 6½ hrs

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO-BAY Job No. 21-2

Mine Project: LAMEFOOT Date 10-4

Location Republic WA Shift: Day ____ Swing ____ Grvyd ✓

Hole Size: HQ ____ NTW ____ NQ ____ Bw44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-200-3	Core Boxes	Soluble Oil
Angle	-79	Cement	Drill Mud
Depth, End	313'	Fondu	Rod Lube
Depth, Begin.	263'	Grout Packer	Size
Drilled	50	Mech Packer	Size
Core Removed	50	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	6 1/2	Cementing	
Reaming		Equip. Repair	2 1/2 remarks
Casing		Delays by Client*	
Setup, Tear Down		Delays by Contractor	
Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) *1 hr move power unit back down & reconn*

Size	Serial No.	Previous Footage	On	Off	Total Footage
Bw44	7-2017/04	new	125		

BITS

REAMING SHELLS

Bw44	05288	1589	0		

Remarks (Explain Delays) 1 hr move & reconnect power unit. Clients due to no power last shift
Broken Theds on drill rod!
Hole out of alingment, Had to realine.

Driller M. LUTZ Helper LESSARD

Approved by Client J R Kuchta

DYNAMIC DRILLING

SHIFT REPORT

Company _____ Job No. _____

Lease Project _____ Date _____

Rig _____ Hours Day _____ Swing _____ Graveyard _____

Rig Type: HCI _____ RTW _____ HCI _____ Bucyrus A _____ Other _____

HOLE INFO

Hole Size _____

Depth _____

Hours, Bit _____

Hours, Bogie _____

Depth _____

Core Recovered _____

Total Runs _____

SUPPLIES

Core Boxes _____ Soluble Oil _____

Cement _____ Core Mud _____

Fondu _____ Rod Lube _____

Drill Pipe _____ Soap _____

Mech Feeder _____ Bits _____

Lost Circulation _____

_____

Other _____

Rod Removal _____ From _____ To _____

Rod Change _____ From _____ To _____ Size _____ Qty. _____

Change Bits _____ From _____ To _____

TIME CHARGES (Hours)

Drilling _____ Cementing _____

Reaming _____ Equip. Repair _____

Coring _____ Delays by Company _____

Trip, Tee Down _____ Delays by Contractor _____

Reaming _____ Rural Delay _____

Setup _____ Other Delay _____

Other (Specify) _____

Size	No.	Total Footage	Previous Footage	On	Off	Total Footage

REAMING SHELLS

Remarks (Explain Delays, Accidents, Lost Time, Lost Footage, Lost Circulation, etc.)

_____

_____

_____

_____

_____

Driller _____ Helper _____

Approved by Owner _____

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO - BAY Job No. 21-2

Mine Project: Lamefoot Date 10-21-97

Location Republic, WA. Shift: Day ____ Swing ____ Grvyd ✓

Hole Size: HQ ____ NTW ____ NQ ____ B ____ A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-000-3	Core Boxes	Soluble Oil
Angle	-45°	Cement	Drill Mud
Depth, End	137	Fondu	Rod Lube
Depth, Begin.	0	Grout Packer	Size
Drilled	137	Mech Packer	Size
Core Removed	137	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	~~[illegible]~~ 9½	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	½ build Helpers deck	Delays by Contractor	
Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
		BITS			
Bw44	L-89865	New	200	358	158
" "	" " "	158	0	58	216
" "	7-2211-02	New	58		
		REAMING SHELLS			
" "	P-3003	583	0		

Remarks (Explain Delays) ____

Driller M. LUTZ Helper Kadalbalcon

Approved by Client [signature]

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO-BAY Job No. 21-2

Mine Project: LAMefoot Date 10-22-97

Location Republic, WA. Shift: Day ____ Swing ____ Grvyd ✓

Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-000-3	Core Boxes	Soluble Oil
Angle	-45°	Cement	Drill Mud
Depth, End	428'	Fondu	Rod Lube
Depth, Begin.	318	Grout Packer	Size
Drilled	110	Mech Packer	Size
Core Removed	110	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW-44	7-2211-02	New	58		
REAMING SHELLS					
BW44	P-3003	583	0		

Remarks (Explain Delays) Hole Started make about 1 or more G.P.M. AT 418'.
Hole IS STILL IN ore AT 428'!

Driller M. LUTZ Helper K. dal-balcon

Approved by Client [signature]

Approved by Client [signature]

SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAMEFOOT Date 10-23-97
Location 2225 Shift: Day ✓ Swing ____ Grvyd ____
Size: HQ ____ NTW ____ NQ ____ BW-44A ____ Other ____

2225 HOLE INFO	2225	
Hole #	28-000-3	28-000-2
Angle	-45° K.D	-32°
Depth, End	488	8
Depth, Begin.	428	0
Drilled	60	8
Core Removed	60	8
# of Runs		

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 7
Reaming ____
Casing ____
Setup, Tear Down 2
Hole Conditioning ____
Survey ____
Other (Specify) ____

Cementing ____
Equip. Repair 1- SHORTEN CHAINS
Delays by Client ____
Delays by Contractor ____
Blast Delay ____
Other Delay ____

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW-44	7-2211-02	NEW	58	438	380T
BW-44	7-2211-03	NEW	438	488	50 STILL GOOD
BW-44	7-2211-03	50	0		
REAMING SHELLS					
BW-44	P-3003	583	0	488	10 71
BW-44	P-3003	1071	0		

Remarks (Explain Delays) HOLE # 3 is MAKING APROX. 2 G.P.M OF WATER.
HOLE # 2 is 2'+8" FROM COLLAR TO SILL

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO-BAY Job No. 21-2

Mine Project: Lamefoot Date 10-23

Location _____ Shift: Day ____ Swing ____ Grvyd ✓

Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-000-2	Core Boxes	Soluble Oil
Angle	-32°	Cement	Drill Mud
Depth, End	158'	Fondu	Rod Lube
Depth, Begin.	8'	Grout Packer	Size
Drilled	150	Mech Packer	Size
Core Removed	150	Lost Circulation	
# of Runs		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) ____

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2211-03	50	0		

BITS

REAMING SHELLS

11 11	P-3003	1071	0		

Remarks (Explain Delays) ____

Driller M. LUTZ Helper K. balbalton

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client _____ Job No. _____
Job Report _____ Date _____
Hole _____ Shift Day ____ Swing ____ Grave ____
Hole No. ____ MW ____ NO ____ Bit ____ Diameter ____

HOLE INFO	SUPPLIES
Hole Depth _____	Cole Doses _____ Sodium Cl _____
Angle _____	Calcium _____ Drill Mud _____
Hole Size _____	Foam _____ Mud Lube _____
Depth _____	Drill Water _____ Size _____
Casing _____	Main Water _____ Size _____
Casing Installed _____	Low Chlorination _____
Left Hole _____	_____
	Other _____

Drill Pressure _____ From _____ To _____
Rod Check _____ From _____ To _____ Size _____ OD _____
Cement Grout _____ From _____ To _____

TIME CHARGES (Hours)

Drilling _____ Contracting _____
Reaming _____ Equip. Repair _____
Casing _____ Delays by Client _____
Pull Two Down _____ Delays by Contractor _____
Mobilizing _____ Rain Delay _____
Other _____ Other Delay _____
Other (Specify) _____

Size	Serial No.	Previous Footage	On	Off	Total Footage
Bit No. _____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

REAMING SHELLS

Size _____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

Remarks (Explain Delays) _____

Operator _____ Driller _____

Approved by Client _____

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAME FOOT Date 10-24-97
Station 2225 Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO

Hole # 28-000-2
Angle -32°
Depth, End 328
Depth, Begin. 158
Drilled 170
Core Removed 170
# of Runs ____

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 9
Reaming ____
Casing ____
Set Up, Tear Down ____
Hole Conditioning ____
Survey ____
Other (Specify) ____

Cementing ____
Equip. Repair ____
Delays by Client ____
Delays by Contractor ____
Blast Delay ____
Other Delay 1- SAFETY MEETING

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW-44	7-2211-03	50	BITS	0	228	278T
BW-44	L-89867	NEW		228		

REAMING SHELLS

BW-44	P-3003	1071		0		

Remarks (Explain Delays) HOLE #2 ISN'T MAKING ANY WATER AT 328'

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

SHIFT REPORT

Client ECHO BAY Job No. 21

Mine Project: LAME FOOT Date 10-27-97

Location 2225 Shift: Day ✓ Swing ____ Grvyd ____

Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO

225

Hole #	28-000-2	28-000-1
Angle	-32° T.D.	-8°
Depth, End	378	103
Depth, Begin.	328	0
Drilled	50	103
Core Removed	50	103
# of Runs		

SUPPLIES

Core Boxes ____ Soluble Oil ____

Cement ____ Drill Mud ____

Fondu ____ Rod Lube ____

Grout Packer ____ Size ____

Mech Packer ____ Size ____

Lost Circulation ____

Other ____

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 8 1/2 Cementing ____

Reaming ____ Equip. Repair ____

Casing ____ Delays by Client ____

Setup, Tear Down 1 Delays by Contractor ____

Hole Conditioning ____ Blast Delay ____

Survey ____ Other Delay 1/2 - NO POWER 2

Other (Specify) ELECTRICIANS TURNED POWER OFF.

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	L-89867	NEW	228	378	150 Still Good
BW-44	" "	150	0		

REAMING SHELLS

BW-44	P-3003	1071	0	378	1,449
BW-44	" "	1,449	0		

Remarks (Explain Delays) HOLE #2 is MAKING About 3 G.P.M of WATER. HOLE #1 isn't MAKING ANY WATER AT 103'.

FORGOT THE COLLAR TO SILL MEASUREMENT. TRY TO Remember NEXT SHIFT.

Driller DECKER Helper J. OSLER

Approved by Client [signature]

Driller A. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAMEFOOT Date 10-28-97
Location Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW-44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	28-000-1	Core Boxes	
Angle	-8°	Cement	
Depth, End	288	Fondu	
Depth, Begin.	103	Grout Packer	Size
Drilled	185	Mech Packer	Size
Core Removed	185	Lost Circulation	
# of Runs		Other	
		Soluble Oil	
		Drill Mud	
		Rod Lube	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW-44	L-89867	150	0	203	353T
BW-44	7-2211-05	NEW	203		
REAMING SHELLS					
BW-44	P-3003	1,449	0		

Remarks (Explain Delays) COLLAR TO SILL IS 5FT. 4IN.
HOLE NOT MAKING ANY [redacted] WATER AT 288'

Driller DECKER/JESS Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Crew _____ Job No _____

Date Finish _____ Date _____

Rig _____ Start Day ✓ Swing ___ Night ___

Hole Size No. ___ NTW ___ NQ ___ BWT ✓ A ___ Other ___

HOLE INFO	SUPPLIES
Hole # _____	Core Boxes _____ Spacers Qty _____
Angle _____	Casing _____ Grid Size _____
Depth Start _____	Rings _____ Rod Lube _____
Depth End _____	Drill Pipe _____ Size _____
Date _____	Mech Reamer _____ Size _____
Core Received _____	Total Completion _____
# of Runs _____	
	Other _____

Fuel Issued _____ From _____ To _____

Fuel Used _____ From _____ To _____ Size _____ Qty _____

Cement Drilled _____ From _____ To _____

TIME CHARGES (HOURS)

Drilling _____ Core Handling _____

Reaming _____ Equip Repair _____

Casing _____ Delays by Client _____

Trip Tear Down _____ Delays by Contractor _____

Conditioning _____ Rest Delay _____

Survey _____ Other Delay _____

Other (specify) _____

Size	Serial No.	Previous Footage	BITS On	Off	Total Footage
BLW	2-95562	1674	0	1703	2377
BLW	2-22465	1670	1703		

REAMING SHELLS

BLW	2-5903	1697	0

Remarks (Explain Delays) Called at 7:00 still is [illegible] [illegible] 2 & 4

Note Partial Test Value 2 0.5 [illegible]

Approved by Crew _____

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAMEFOOT Date 10-29-97
Location 2225 Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO

Hole # 225-28-000-1
Angle -8°
Depth, End 418 T.D.
Depth, Begin. 288
Drilled 130
Core Removed 130
# of Runs ____

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 9
Reaming ____
Casing ____
Trip, Tear Down ____
Hole Conditioning ____
Survey ____
Other (Specify) ____

Cementing ____
Equip. Repair 1- CHANGED SUPPORT LEG
Delays by Client ____
Delays by Contractor ____
Blast Delay ____
Other Delay ____

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2211-05	NEW	203	338	135 STILL GOOD
BW-44	L-91908 TEST BIT	[redacted] NEW	338	418	80 STILL GOOD

REAMING SHELLS

BW-44	P-3003	1449	0	418	1867

Remarks (Explain Delays) HOLE IS MAKING APROX. 1½ G.P.M OF WATER AT 288'

9.7 GAL. FUEL FOR KUBOTA ✓

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAME FOOT Date 10-8-94
Location: REPUBLIC WA Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO

Hole # 225-28-100-1
Angle -30
Depth, End 53
Depth, Begin. 0
Drilled 53
Core Removed 53
# of Runs

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 3HR
Reaming
Casing
Set up, Tear Down 5½ HR
Hole Conditioning
Survey
Other (Specify) 2HR SUPPLYS

Cementing
Equip. Repair *
Delays by Client 1HR NO POWER
Delays by Contractor
Blast Delay
Other Delay ½ HR WATER IN AIR LINE

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW44	288395	98	0		
REAMING SHELLS					
BW44	05288	2047	0		

Remarks (Explain Delays)
* electrician weren't aware of a problem — perhaps it would help to write a longer description of the power problem in an attempt to prevent it in future.

Driller HEIKMAN Helper OSLEN
Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO-BAY Job No. 21-2
Mine Project: Lamefoot Date 10-8-97
Location Republic WA Shift: Day ____ Swing ____ Grvyd X
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-100-1	Core Boxes	Soluble Oil
Angle	-30°	Cement	Drill Mud
Depth, End	177'	Fondu	Rod Lube
Depth, Begin.	53	Grout Packer	Size
Drilled	124	Mech Packer	Size
Core Removed	124	Lost Circulation	
# of Runs		Other	

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	BITS On	Off	Total Footage
BW44	L88395	98	0	168	266
1111	L89862	new	168		

REAMING SHELLS

11 11	05288	2049	0		

Remarks (Explain Delays)

Driller M. LUTZ Helper K. dalbalcon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAMEFOOT Date 10-9-97
Location _____ Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		SUPPLIES			
Hole #	28-100-1	Core Boxes		Soluble Oil	
Angle	-30°	Cement		Drill Mud	
Depth, End	288	Fondu		Rod Lube	
Depth, Begin.	177	Grout Packer		Size	
Drilled	111	Mech Packer		Size	
Core Removed	111	Lost Circulation			
# of Runs					
		Other			

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	6	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) 4 HRS. WALK AROUND FOR ESCAPEWAYS + REFUGE CHAMBERS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW-44	489862	NEW	168		
REAMING SHELLS					
BW-44	05288	2049	0		

Remarks (Explain Delays) WALK AROUND FOR KEVIN D.

Driller HELLMAN / DECKER Helper J. OSHER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO-BAY Job No. 21-2
Mine Project: Lamefoot Date 10-9-97
Location: Republic Shift: Day ___ Swing ___ Grvyd ✓
Hole Size: HQ ___ NTW ___ NQ ___ B ___ A ___ Other ___

HOLE INFO

Hole # 28-100-1 + 2
Angle -30° / -45°
Depth, End 355 TD / 58'
Depth, Begin. 288 / -0-
Drilled 67 / 58
Core Removed 67 / 58
# of Runs ___

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 9
Reaming ___
Casing ___
Setup, Tear Down ½ Hole
Hole Conditioning ½ PACKER #1
Survey ___
Other (Specify) ___

Cementing ___
Equip. Repair ___
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
Bw44	189862	new	168	355	187
" "	" " "	187	0	8	195
" "	7-2016/06	New	8		
REAMING SHELLS					
" "	05288	2049	0	355	2404
" "	" " "	2404	0		

Remarks (Explain Delays) ½ hr. tear down + set up
Hole #2, sill to collar is 1.5 + #1 is
3'. ½ hr set packer in Hole #1.
Hole #2 Looked like it was makeing a lot
of wast rock, so I cut it short?
(Mike - Don't cut these holes short +
(see note)

Driller M. Lutz Helper K. dalbalcon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO BAY Job No. 21
Mine Project: LAMEFOOT Date 10-10-97
Location Republic Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO

Hole # 28-100-2
Angle
Depth, End 212
Depth, Begin. 58
Drilled 154
Core Removed 154
# of Runs

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 10
Reaming
Casing
Setup, Tear Down
Hole Conditioning
Survey
Other (Specify)

Cementing
Equip. Repair
Delays by Client
Delays by Contractor
Blast Delay
Other Delay

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2016-06	NEW	8		

REAMING SHELLS

BW-44	05288	2404	0		

Remarks (Explain Delays)

Driller HELLMAN / DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO-BAY Job No. 21-2
Mine Project: LAMEFOOT Date 10-10-97
Location Republic WA Shift: Day ____ Swing ____ Grvyd ✓
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-100-2	Core Boxes	Soluble Oil
Angle	-45°	Cement	Drill Mud
Depth, End	308'	Fondu	Rod Lube
Depth, Begin.	212	Grout Packer	Size
Drilled	96	Mech Packer	Size
Core Removed	96	Lost Circulation	
# of Runs		Other	

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	9½	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning	½ Ream To bottom	Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2016-06	New	8	270	262
" " "	L-89864	N	270		

BITS

REAMING SHELLS

" "	05288	2404	0		

Remarks (Explain Delays)
Tryed To run bit back To bottom After 3 runs, Hole was To Tiet, Had To ream from 10' To 270'. ½ hr.

Driller M. LUTZ Helper K. dalbakon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO BAY Job No. 21
Mine Project: LAME FOOT Date 10-13-97
Location Republic Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-100-2	Core Boxes	Soluble Oil
Angle	-45°	Cement	Drill Mud
Depth, End	368	Fondu	Rod Lube
Depth, Begin.	308	Grout Packer	Size
Drilled	60	Mech Packer	Size
Core Removed	60	Lost Circulation	
# of Runs		Other	

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	5	Cementing	
Reaming		Equip. Repair	4
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey	1	Other Delay	

Other (Specify) ____

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW-44	L-89864	NEW	BITS	270	328	58T
BW-44	7-2017-05	NEW		328		

REAMING SHELLS

BW-44	05288	2404	0		

Remarks (Explain Delays) REPAIRED - POP OFF VALVE; FLOW METER, Hyd. HAND PUMP. ADJUSTED CHAIN + SLIDE SHOES. HELPER GOT SICK AND LEFT AT 1:30. (He Rode out when survey was finished)

Driller K. DECKER Helper J. OSLER - 8HR.

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO-BAY Job No. 21-2
Mine Project: Lame foot Date 10-13-97
Location Shift: Day ___ Swing ___ Grvyd ✓
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	28-100-2	Core Boxes	
Angle	-45	Cement	
Depth, End	428'	Fondu	
Depth, Begin.	368'	Grout Packer	Size
Drilled	60'	Mech Packer	Size
Core Removed	60'	Lost Circulation	
# of Runs		Other	

Soluble Oil ___
Drill Mud ___
Rod Lube ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	7 1/2	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)	1/2 BAD AIR		

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
Bw44	7-2017-05	New	328		

REAMING SHELLS

Bw44	05288	2404	0		

Remarks (Explain Delays)
Hole looks like still in ore? Stoped drilling to make shure its not waste.

Driller M. LUTZ Helper Kdal Balcom

Approved by Client [signature]

DYNAMIC DRILLING

SHIFT REPORT

Client _____ Job No _____

Project _____ Date _____

Rig _____ Shift Date _____ Shift _____ Drill _____

Hole Size HQ _____ NQ _____ BQ _____ Other _____

HOLE INFO	SUPPLIES
Hole Number _____	Core Boxes _____ Spare Oil _____
Angle _____	Casing _____ Drill Mud _____
Depth Start _____	Fuel _____ Pipe Lube _____
Depth Depth _____	Drill Rods _____ Size _____
Finish _____	Bitch Rods _____ Size _____
Core Recovered _____	Core Condition _____
# of Runs _____	_____
	Other _____

Rod Number _____ From _____ To _____

Rod Drill _____ From _____ To _____ Size _____ CS? _____

Casing Drill _____ From _____ To _____

TIME CHARGES (Hours)

Drilling _____ Cementing _____

Reaming _____ Stuck Rods _____

Coring _____ Delays by Client _____

Run Tube Down _____ Delays by Contractor _____

Time Coring _____ Equip Delay _____

Survey _____ Other Delay _____

Other (Specify) _____

Date	Shift	Previous Footage	Bit	On	Off	Total Footage

REMARKS SHEET

Footage (Please Notify) _____

Notes _____

Approved by Client _____

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Mine Project: LAMEFOOT Date 10-14-97
Location Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW-44A ___ Other ___

HOLE INFO

Hole # 28-100-2
Angle -45°
Depth, End 518 T.D.
Depth, Begin. 428
Drilled 90
Core Removed 90
# of Runs

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 9
Reaming
Casing
Rig up, Tear Down 1
Hole Conditioning
Survey
Other (Specify)

Cementing
Equip. Repair
Delays by Client
Delays by Contractor
Blast Delay
Other Delay

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2017-05	NEW	328	518	190 STILL GOOD

REAMING SHELLS

BW-44	05288	2404	0	518	2922

Remarks (Explain Delays) ~11 TO 12 GAL/min. OF WATER AT 518'

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING

Shift REPORT

Client: Cells Rdy Job No: 21

Job Name: LAKEFRAT Date: 20-10-92

Rig: Shift Day 1 Crew: Crew 4

Hole Size (HO): 17½" HO: 17½"-8¾" Other:

HOLE DATA		SUPPLIES	
Hole #	2	Cone Bit	Lubricate Oil
Depth	5	Diamond	Drill Mud
Depth Out	5	Pencils	Rod Lube
Depth Depth	5	Grind Plates	Bits
Drilled	0	Mach Plates	Size
Core Received	0	Lost Consumables	
# of Runs			
		Other	

Test Started	From	To		
Test Ended	From	To	Size	Drill #
Core not Cored	From	To		

TIME CHARGES (Hours)

Drilling	0	Cementing	
Reaming		Stuck Pipe	
Coring		Delays by Client	
Core Open	1	Delays by Contractor	
Hole Conditioning		Blow Down	
Survey		Other Delay	
Core Handling			

Date	Bit No.	Previous Footage	Bit Type	Cir.	Dir.	Total Footage
Bit-49	7-20-2-04	4224	8½"	3-3-2	S/4	4204

REAMING SHELLS

Bit-49	0	2532	0	S/4 2122

Reamer (Length Center) = 1120 2 2/2 1/2 0 of 1/2 22

Driller: Kdrake Helper: J. Osler

Approved by Client: [illegible]

DYNAMIC DRILLING
SHIFT REPORT

Client _____ Job No. _____

Mine Project: _____ Date 10/14/97

Location _____ Shift: Day ____ Swing ____ Grvyd ✓

Hole Size: HQ ____ NTW ____ NQ ____ B ____ A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-100-3	Core Boxes	Soluble Oil
Angle	-62°	Cement	Drill Mud
Depth, End		Fondu	Rod Lube
Depth, Begin.		Grout Packer	Size
Drilled		Mech Packer	Size
Core Removed		Lost Circulation	
# of Runs		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling _____ Cementing _____

Reaming _____ Equip. Repair 1hr clean areas & Kubota

Casing _____ Delays by Client ½ Packer #2

Setup, Tear Down 2 hrs Delays by Contractor _____

Hole Conditioning _____ Blast Delay _____

Survey _____ Other Delay * 6hr Bad Air

Other (Specify) ½ clean drill station area up.

Size	Serial No.	Previous Footage		On	Off	Total Footage
Bw44	7-2017-05	190	BITS	0		

REAMING SHELLS

Bw44	05-288	2922			

Remarks (Explain Delays) 2 hrs Had Trouble ankering drill down, ½ hr set macainical Packer #2, 6 hrs Air not safe to work in, Help said He Had chest pains, from diesel exost in AIR" came out at 10:30 P.M. Helper went home.

* EB shifter-R. Hobson checked it out & wrote in book; "Vent was not so bad that they couldnt work"

Driller M. Lutz Helper K. dalbalcon

(we will test air today however)

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY — Job No. 21
Mine Project: LAMEFOOT — Date 10-15-97
Location: Republic — Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44A ____ Other ____

HOLE INFO		SUPPLIES			
Hole #	28-100-3	Core Boxes		Soluble Oil	
Angle	-62°	Cement		Drill Mud	
Depth, End	143	Fondu		Rod Lube	
Depth, Begin.	0	Grout Packer		Size	
Drilled	143	Mech Packer		Size	
Core Removed	143	Lost Circulation			
# of Runs		Other			

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW-44	7-2017-05	190	0		
REAMING SHELLS					
BW-44	05-288	2922	0		

Remarks (Explain Delays)

NO WATER FLOW

Driller K. DECKER — Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO-BAY Job No. 21-2
Mine Project: Lamefoot mine Date 10-15-97
Location Republic, WA. Shift: Day ____ Swing ____ Grvyd ✓
Hole Size: HQ ____ NTW ____ NQ ____ B ____ A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-100-3	Core Boxes	Soluble Oil
Angle	-62°	Cement	Drill Mud
Depth, End	238'	Fondu	Rod Lube
Depth, Begin.	143	Grout Packer	Size
Drilled	95'	Mech Packer	Size
Core Removed	95'	Lost Circulation	
# of Runs		Other	

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	9	Cementing	
Reaming		Equip. Repair	1/2
Casing		Delays by Client	
Trip, Tear Down		Delays by Contractor	
Hole Conditioning	1/2 * (not client) ~~X~~	Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	BITS On	Off	Total Footage
Bw44	7-2017-05	190	0	183	373
" "	7-2017-06	New	183		

Size	Serial No.	Previous Footage	REAMING SHELLS On	Off	Total Footage
Bw44	05-288	2922	0	183	3105
" "	P-3003	New	183		

Remarks (Explain Delays) Core barrel was cracked, bit + reamen shell needed changed, Hole was very tiet, Had to ream from 20' to 183'. Hole started maken more water at 163'!.

Driller M. Lutz Helper K. dal-balcon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO BAY Job No. 21

Mine Project: LAME FOOT Date 10-16-97

Location Republic Shift: Day ✓ Swing ____ Grvyd ____

Hole Size: HQ ____ NTW ____ NQ ____ BW-44A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-100-3	Core Boxes	Soluble Oil
Angle	-62°	Cement	Drill Mud
Depth, End	338	Fondu	Rod Lube
Depth, Begin.	238	Grout Packer	Size
Drilled	100	Mech Packer	Size
Core Removed	100	Lost Circulation	
# of Runs		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	BITS On	Off	Total Footage
BW-44	7-2017-06	NEW	183		

REAMING SHELLS

BW-44	P-3003	NEW	183		

Remarks (Explain Delays) HOLE IS MAKING APROX. 10-12 GAL. OF WATER A MIN. AT 338'

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO BAY Job No. 21
Mine Project: LAMEFOOT Date 10-17-97
Location Shift: Day ✓ Swing Grvyd
Hole Size: HQ NTW NQ BW-44 A Other

HOLE INFO		SUPPLIES	
Hole #	28-100-3	Core Boxes	Soluble Oil
Angle	-62°	Cement	Drill Mud
Depth, End	408 T.D.	Fondu	Rod Lube
Depth, Begin.	338	Grout Packer	Size
Drilled	70	Mech Packer	Size
Core Removed	70	Lost Circulation	
# of Runs			
		Other	

Feet Reamed From To
Feet Cased From To Size C/S #
Cement Drilled From To

TIME CHARGES (Hours)

Drilling	6	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	2	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) 2HR. RESETUP ON HOLE #1 & RETRIEVE GROUT PACKER

	Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS	BW-44	7-2017-06	NEW	183	408	225 STILL GOOD
REAMING SHELLS	BW-44	P-3003	NEW	183	408	225 STILL GOOD

Remarks (Explain Delays) 2HR. ON RETRIEVE OF PACKER AT ECHO BAY'S REQUEST. HOLE #3 IS MAKING APROX. 12 TO 15 G.P.M. AT HOLE DEPTH OF 408'. HOLE #1 IS MAKING JUST A SMALL TRICKLE OF WATER AFTER THE GROUT PACKER WAS REMOVED.

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 21
Project: Lamefoot Date 11-20-97
Location 2225 Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ B ___ A ___ Other ___

HOLE INFO		SUPPLIES			
Hole #		Core Boxes		Soluble Oil	
Angle		Cement		Drill Mud	
Depth, End		Fondu		Rod Lube	
Depth, Begin.		Grout Packer		Size	
Drilled		Mech Packer		Size	
Core Removed		Lost Circulation			
# of Runs					
		Other			

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling		Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	10-station move	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
REAMING SHELLS					

Remarks (Explain Delays) Station move - 99%
None

Driller C. Jess Helper ___
Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Project: LAME FOOT Date 11-21-97
Location 2225 Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-100-4	Core Boxes	
Angle	-19°	Cement	
Depth, End	66	Fondu	
Depth, Begin.	0	Grout Packer	Size
Drilled	66	Mech Packer	Size
Core Removed	66	Lost Circulation	
# of Runs			
		Other	

Soluble Oil					
Drill Mud					
Rod Lube					

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	4	Cementing	
Reaming		Equip. Repair	
Coring		Delays by Client	
Setup, Tear Down	5 - FINISH STATION MOVE	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) 1 - MOVE ELECTRICAL BOX DOWN RAMP

Size	Serial No.	Previous Footage		On	Off	Total Footage
BW-44	7-2315-03	250	BITS	0	7	257T
BW-44	7-2471-02	NEW		7		
			REAMING SHELLS			
BW-44	P-1270	4260		0		

Remarks (Explain Delays) COLLAR TO SILL IS 3' FT.-#4
NO WATER AT 66'.

K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 21
Project: LONEFOOT Date 11-21-97
Location 2225 Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW 44 A ___ Other ___

HOLE INFO

Hole # 28-100-4
Angle -19°
Depth, End 293
Depth, Begin. 66
Drilled 227
Core Removed 227
# of Runs ___

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 10
Reaming ___
Coring ___
Setup, Tear Down ___
Hole Conditioning ___
Survey ___
Other (Specify) ___

Cementing ___
Equip. Repair ___
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ___

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
B-44	7-2471-02	New	7'	76'	69' T
	7-2211/10	New	76'		

REAMING SHELLS

Remarks (Explain Delays) Hole Not making any water @ 300'

C. Jess Helper out

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Project: LAME FOOT Date 11-22-97
Location 2225 Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		
Hole #	28-100-4	#5
Angle	-19°	-37°
Depth, End	373 T.D.	105
Depth, Begin.	293	0
Drilled	80	105
Core Removed	80	105
# of Runs		

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 8 1/2 Cementing ____
Reaming ____ Equip. Repair 1/2 - TIGHTEN CHAIN
Coring ____ Delays by Client ____
Setup, Tear Down 1 Delays by Contractor ____
Hole Conditioning ____ Blast Delay ____
Survey ____ Other Delay ____
Other (Specify) ____

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW-44	7-2211-10	NEW	76	373	297
BW-44	" "	297	0	95	392T
BW-44	7-2212-07	NEW	95		
REAMING SHELLS					
BW-44	P-1270	4260	0	373	4633
BW-44	P-1270	4633	0		

Remarks (Explain Delays) HOLE #4 NOT MAKING ANY WATER AT 373,
COLLAR TO SILL ON HOLE #28-100-5 - IS 2' FT.
NOT MAKING ANY WATER AT 105'

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Project: LAME FOOT Date 11-23-97
Location _____ Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44A ____ Other ____

HOLE INFO		SUPPLIES			
Hole #	Z8-100-5	Core Boxes		Soluble Oil	
Angle	-37°	Cement		Drill Mud	
Depth, End	345	Fondu		Rod Lube	
Depth, Begin.	105	Grout Packer		Size	
Drilled	240	Mech Packer		Size	
Core Removed	240	Lost Circulation			
# of Runs					
		Other			

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Coring		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2212-07	NEW	95		

BITS

BW-44	P-1270	4633	0		

REAMING SHELLS

Remarks (Explain Delays) HOLE #4 is MAKING A TRICKLE OF WATER NOW.
HOLE #5 is MAKING 3 GPM OF WATER AT 320'.

Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Project: LAMEFOOT Date 11-24-97
Location 2225 Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44A ____ Other ____

HOLE INFO		
Hole #	28-100-5	28-100-6
Angle	-37°	-50°
Depth, End	405TD	143
Depth, Begin.	345	0
Drilled	60	143
Core Removed	60	143
# of Runs		

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 9 Cementing ____
Reaming ____ Equip. Repair ____
Coring ____ Delays by Client ____
Setup, Tear Down 1 Delays by Contractor ____
Hole Conditioning ____ Blast Delay ____
Survey ____ Other Delay ____
Other (Specify) ____

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW-44	7-2212-07	NEW	95	405	310
BW-44	" "	310	0	68	378T
BW-44	7-2211-11	NEW	68		
REAMING SHELLS					
BW-44	P-1270	4633	0	405	5038
" "	P-1270	5038	0		

Remarks (Explain Delays) COLLAR TO SILL IS 4" IN. ON HOLE #6, NOT MAKING ANY WATER AT 143'.

CHANGED OIL IN ROTATION UNIT!

K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 21
Project: LAMEFOOT — Date 11-24-97
Location 2225 — Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW 44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	28-100-6	Core Boxes	Soluble Oil
Angle	-50°	Cement	Drill Mud
Depth, End	318	Fondu	Rod Lube
Depth, Begin.	143	Grout Packer	Size
Drilled	175	Mech Packer	Size
Core Removed	175	Lost Circulation	
# of Runs		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	9	Cementing	
Reaming	1 - Ream Cave	Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	BITS	On	Off	Total Footage
BW44	7-2211-11	New		0\268'	223\278'	243' T
BW44	7-2470-2	New		223	268	45T
	7-2211-12	New		278'		

REAMING SHELLS

Remarks (Explain Delays) Hole Caving @ 225'-260'
Hole making 10 gal min of water @ 318'

Driller C. Jess — Helper K. Dal Balcom

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21
Project: LAMEFOOT Date 11-25-97
Location: ____ Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		SUPPLIES			
Hole #	28-100-6	Core Boxes		Soluble Oil	
Angle	-50°	Cement		Drill Mud	
Depth, End	408	Fondu		Rod Lube	
Depth, Begin.	318	Grout Packer		Size	
Drilled	90	Mech Packer		Size	
Core Removed	90	Lost Circulation			
# of Runs					
		Other			

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	8 1/2	Cementing	
Reaming		Equip. Repair	1-WATER SWIVEL
Coring		Delays by Client	
Scrap, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) 1/2 build RAKING ON HELPERS DECK

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW-44	7-2211-12	NEW	278		
REAMING SHELLS					
BW-44	P-1270	5038	0		

Remarks (Explain Delays) HOLE IS MAKING ABOUT 10-15 GPM OF WATER.

Gobble! Gobble! ☺

K. DECKER Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 21
Project: Lomecoot — Date 11-25-97
Location: 2225 — Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW 44 A ___ Other ___

HOLE INFO		SUPPLIES			
Hole #	28-100-6	Core Boxes		Soluble Oil	
Angle	-50°	Cement		Drill Mud	
Depth, End	548	Fondu		Rod Lube	
Depth, Begin.	408	Grout Packer		Size	
Drilled	140	Mech Packer		Size	
Core Removed	140	Lost Circulation			
# of Runs					
		Other			

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Coring		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW 44	7-2211-12	New	278'	548'	270' Good

REAMING SHELLS

BW 44	P-1270	5038	0	548	5586'

Remarks (Explain Delays): Hole making @ 10 Gal. off water @ 548'

C. Jess — Helper K. Dal Balcom

Approved by Client: [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO-BAY Job No. 20-2
Mine Project: LAMEFOOT Date 9-16-97
Location: Republic WA. Shift: Day ___ Swing X Grvyd X
Hole Size: HQ ___ NTW ___ NQ ___ B ___ A ___ Other ___

HOLE INFO	SUPPLIES	
Hole # 28-300-3	Core Boxes	Soluble Oil
Angle	Cement	Drill Mud
Depth, End	Fondu	Rod Lube
Depth, Begin.	Grout Packer	Size
Drilled	Mech Packer	Size
Core Removed	Lost Circulation	
# of Runs		
	Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling		Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	1hr safty meeting
Setup, Tear Down	9 SET UP	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
REAMING SHELLS					

Remarks (Explain Delays) hooked up Hydro Hoses, Take more supply down To drill, Installed new chuck JAWS. Traveld To #1 drill for Hydro oil + more supplys.

Driller M. LUTZ Helper K. DALBOLGON

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client Echo BAY Job No. 2[illegible]-2

Mine Project: LAMEFOOT Date 9-17-97

Location Republic Wa Shift: Day ✓ Swing ____ Grvyd ____

Hole Size: HQ ____ NTW ____ NQ ____ B W44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #		Core Boxes	Soluble Oil
Angle		Cement	Drill Mud
Depth, End		Fondu	Rod Lube
Depth, Begin.		Grout Packer	Size
Drilled		Mech Packer	Size
Core Removed		Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling		Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down	10Hr	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) 2Hr SUPPLYS

Size	Serial No.	Previous Footage	On	Off	Total Footage
		BITS			
		REAMING SHELLS			

Remarks (Explain Delays) setting up IN STA # 28-300-B

Driller Hellman Helper J. Osler

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay — Job No. 21-2
Mine Project: Lamefoot — Date: 9-18-95
Location: Republic Mine — Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	28-300-3	Core Boxes	
Angle	-75	Cement	
Depth, End	28	Fondu	
Depth, Begin.	0	Grout Packer	Size
Drilled	28	Mech Packer	Size
Core Removed	28	Lost Circulation	
# of Runs			
		Other	

Soluble Oil ___ Drill Mud ___ Rod Lube ___

Feet Reamed 5 From 0 To 5
Feet Cased 5 From 0 To 5 Size NQ C/S #
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	2½ HR	Cementing	
Reaming	½ HR	Equip. Repair	
Casing	1 HR	Delays by Client	
Setup, Tear Down	6 HR	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	L80508	New	0		

BITS

REAMING SHELLS

BW44	05288	New	0		

Remarks (Explain Delays) ___

Driller Hellman Helper Osper

Approved by Client [signature]

DYNAMIC DRILLING

SHIFT REPORT

Client _____ Job No. _____

Drilling Foreman _____ Date _____

Rig No. _____ Shift Begins _____ Ends _____

Hole Size _____ Hrs _____ No. _____ Bit No. _____ Depth _____

HOLE INFO

Hole # _____

Angle _____

Depth Start _____

Depth End _____

Dates _____

Core Recovered _____

Left Hole _____

SUPPLIES

Core Boxes _____ Solvents Qty _____

Cement _____ Dye Mud _____

Points _____ Pipe Tube _____

Drill Pipe _____ Size _____

Mech. Broker _____ Size _____

Lost Circulation _____

Other _____

Pipe Planned _____ From _____ To _____

Pipe Cased _____ From _____ To _____ Size _____

Cement Grouted _____ From _____ To _____

TIME CHARGES (Hours)

Drilling _____ Cementing _____

Reaming _____ Equip. Repair _____

Coring _____ Delays by Client _____

Trip In Pipe _____ Delays by Client actor _____

Trip Out Pipe _____ Blast Delay _____

Survey _____ Other Delay _____

Other Work _____

Size	Type	Previous Footage	On	Off	Total Footage

REAMING SHELLS

Remarks (Explain Delays)

Driller _____ Helper _____

Approved by Client _____

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO-BAY Job No. 21-2
Mine Project: LAMEFOOT Date 9-18-97
Location: Republic WA. Shift: Day ___ Swing ___ Grvyd X
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	28-300-3	Core Boxes	
Angle	-75°	Cement	
Depth, End	127'	Fondu	
Depth, Begin.	28'	Grout Packer	Size
Drilled	99'	Mech Packer	Size
Core Removed	99	Lost Circulation	
# of Runs		Other	

Soluble Oil ___
Drill Mud ___
Rod Lube ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	9 1/2	Cementing	
Reaming		Equip. Repair	1/2 Hydral Hose
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	L80508	new	0		

REAMING SHELLS

BW44	05288	New	0		

Remarks (Explain Delays)

Driller M. LUTZ Helper K. Dalbalcon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client [illegible] Job No. [illegible]

Mine Project [illegible] Date [illegible]

Location [illegible] Shift Day Swing Grey [illegible]

Hole Size: HQ NTW NO [illegible] A Other

HOLE INFO		SUPPLIES	
Hole # [illegible]		Core Boxes	Soluble Oil
Angle [illegible]		Cement	Drill Mud
Depth, End [illegible]		Fordu	Rod Lube
Depth, Begin [illegible]		Grout Packer	Size
Drilled [illegible]		Mech Packer	Size
Core Removed [illegible]		Lost Circulation	
# of Runs			
		Other	

Rest Reamed From To

Rest Cased From To Size [illegible]

Cement Drilled From To

TIME CHARGES (Hours)

Drilling	[illegible]	Cementing	
Reaming		Equip Repair	[illegible]
Casing		Delays by Client	
Pump Test Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)	[illegible]		

Size	Serial No.	Previous Footage	BITS	On	Off	Total Footage
[illegible]	[illegible]	[illegible]		0		

REAMING SHELLS

[illegible]	[illegible]	[illegible]	0		

Remarks (Explain Below)

Driller [illegible] Helper [illegible]

Approved by Client [illegible]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21-2
Mine Project: LAMEFOOT Date 9-19-97
Location: Republic wa Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-300-3	Core Boxes	
Angle	-75	Cement	
Depth, End	267	Fondu	
Depth, Begin.	127	Grout Packer	Size
Drilled	140	Mech Packer	Size
Core Removed	140	Lost Circulation	
# of Runs		Other	

Soluble Oil ____
Drill Mud ____
Rod Lube ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10 Hr	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Rig Up, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) ____

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW44	L80508	New	0	268	
11	L88388	New	268		
REAMING SHELLS					
BW44	05288	New	0		

Remarks (Explain Delays) ____

Driller HELLMAN Helper JOSHEW

Approved by Client [signature]

DYNAMIC DRILLING

DRIFT REPORT

Client _____ Job No. _____

Mine Project _____ Date _____

Location _____ Shift Day ☐ Swing ☐ Grave ☐

Mine Site NO. _____ NTW _____ NO. _____ Elev. _____ Owner _____

HOLE INFO		SUPPLIES	
Hole # _____		Core Boxes _____	Bags/Jars Oil _____
Angle _____		Cement _____	Oil Mud _____
Depth End _____		Fuses _____	Rod Lube _____
Depth Begin _____		Gravel Packer _____	Bits _____
Tested _____		Mech. Packer _____	Size _____
Core Recovered _____		Lost Circulation _____	
# of Runs _____			
		Other _____	

Fwd Reamed _____ From _____ To _____

Fwd Ream _____ From _____ To _____ Size _____ Cost $ _____

Cement Drilled _____ From _____ To _____

TIME CHARGES (Hours)

Drilling	_____	Cementing	_____
Reaming	_____	Bonus Engr.	_____
Coring	_____	Delays by Client	_____
Pipe Tear Down	_____	Delays by Contractor	_____
Pipe Cementing	_____	Rest Delay	_____
Survey	_____	Other Delay	_____
Other (Specify)	_____		

Size	Total In	Previous Footage	Out	Total Footage
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

REAMING BITS

_____	_____	_____	_____

Remarks (Events Delay)

Date _____ Name _____

Approved by Client _____

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO-BAY Job No. 21-2
Mine Project: LAMEFOOT Date 9-19-97
Location: Republic WA. Shift: Day ____ Swing ____ Grvyd ✓
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-300-3	Core Boxes	
Angle	-75°	Cement	
Depth, End	307'	Fondu	
Depth, Begin.	267'	Grout Packer	Size
Drilled	40'	Mech Packer	Size
Core Removed	40'	Lost Circulation	
# of Runs			
		Other	

Feet Reamed 5 From 5 To 10
Feet Cased 5 From 5 To 10 Size NQ C/S #
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	7½	Cementing	
Reaming	½	Equip. Repair	
Casing	1 hr = 5 foot more	Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning	½	Blast Delay	
Survey		Other Delay	

Other (Specify) ½ supplies, 100' Rods

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW44	L88388	New	208		
REAMING SHELLS					
BW44	05288	New	0		

Remarks (Explain Delays) Slow Drilling

Driller M. LUTZ Helper K. DALBALCON

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21-2
Mine Project: LAMEFOOT Date 9-22-97
Location: REPUBLIC WA Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ B W44 A ____ Other ____

HOLE INFO

Hole # 28-300-3
Angle -75
Depth, End 408
Depth, Begin. 307
Drilled 101
Core Removed 101
# of Runs ____

SUPPLIES

Core Boxes ____ Soluble Oil ____
Cement ____ Drill Mud ____
Fondu ____ Rod Lube ____
Grout Packer ____ Size ____
Mech Packer ____ Size ____
Lost Circulation ____
Other ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling 8½ HR
Reaming ____
Casing ____
Setup, Tear Down ____
Hole Conditioning ____
Survey ____
Other (Specify) ____

Cementing ____
Equip. Repair ____
Delays by Client ____
Delays by Contractor ____
Blast Delay ____
Other Delay 1½ HR NO POWER

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	188388	New	208		

REAMING SHELLS

BW44	05288	New	0		

Remarks (Explain Delays) ____

Driller HELLMAN Helper OSLER

Approved by Client D. Knecht

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO-BAY Job No.:
Mine Project: LAMEFOOT Date: 9-22-97
Location: Republic, WA. Shift: Day ___ Swing ___ Grvyd X
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	28-300-3/2	Core Boxes	Soluble Oil
Angle	-75°/-50°	Cement	Drill Mud
Depth, End	448	Fondu	Rod Lube
Depth, Begin.	408	Grout Packer	Size
Drilled	40	Mech Packer	Size
Core Removed	40	Lost Circulation	
# of Runs		Other	

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	5.5	Cementing	
Reaming		Equip. Repair	3hrs
Casing		Delays by Client	
Setup, Tear Down	1hr.	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify): 1/2 INSALLED AN N.Q. PACKER Hole #3

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	L88388	NEW	208	448	240

REAMING SHELLS

BW44	05288	NEW	0	448	448

Remarks (Explain Delays): Brock Hydro. Fitting in pieces of TEAR DOWN & SETUP. HAD TO walk out of bottom of mine. Sill to collar for Hole #3 IS 0.0.

Driller: M. LUTZ Helper: K. DALBAGON

Approved by Client: [signature]

DYNAMIC DRILLING
SHIFT REPORT

Job No. _____

Area Foreman _____ Date _____

Rig No. _____ Shift: Day ____ Swing ____ Grave X

Crew: MC ____ LW ____ JD ____ BC/JAY A ____ Other _____

HOLE INFO	SURPLUSES
Hole # _____	Core Boxes ____ Scales Oil ____
Angle _____	Cement ____ Drill Mud ____
Depth: Log _____	Points ____ Fire Lures ____
Depth: Begin _____	Grove Packers ____ Soap ____
Twist _____	Mech. Packer ____ Skip ____
Core Recovery _____	Lost Cylinders ____
Y of Core _____	
	Other _____

Feet Drilled _____ From _____ To _____

Feet Cored _____ From _____ To _____ Size _____ PSA _____

Core Boxes _____ From _____ To _____

TIME CHARGES (Hours)

Drilling _____ Commuting _____

Reaming _____ Trip, Repair _____

Coring _____ Delays by Client _____

Log, Test Down _____ Delays by Contractor _____

Core Operation _____ Great Delay _____

Other _____ Other Delay _____

Date Spudded _____

Size	Bore No.	Previous Footage	On	Off	Total Footage
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

REAMING DETAILS

_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

Remarks (Include Delays) _____

_____

_____

_____

_____

_____

Driller _____ Helper _____

Approved by Client _____

DYNAMIC DRILLING
SHIFT REPORT

Client Echo BAY Job No. 21-2

Mine Project: LAMEFOOT Date 9-23-99

Location Republic wa Shift: Day ✓ Swing ____ Grvyd ____

Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-300-2	Core Boxes	Soluble Oil
Angle	-50	Cement	Drill Mud
Depth, End	196	Fondu	Rod Lube
Depth, Begin.	0	Grout Packer	Size
Drilled	196	Mech Packer	Size
Core Removed	196	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10 HR	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) 2HR SUPPLYS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	L88388	240 BITS	0	166	406
11	7-2016/01	New	166		

REAMING SHELLS

BW44	05288	448	0		

Remarks (Explain Delays) ____

Driller HELLMAN Helper OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21-2
Mine Project: LAMEFOOT Date 9-23-97
Location: REPUBLIC, WA. Shift: Day ____ Swing ____ Grvyd ✓
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	27-250-2	Core Boxes	Soluble Oil
Angle		Cement	Drill Mud
Depth, End		Fondu	Rod Lube
Depth, Begin.		Grout Packer	Size
Drilled		Mech Packer	Size
Core Removed		Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling		Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) 2 Hr Show up

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
REAMING SHELLS					

Remarks (Explain Delays)
2 hours Show up, Paul got sick at the drill

Driller M. LUTZ Helper K. Balbacon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21-2
Mine Project: LAMEFOOT Date 9-24-97
Location Republic wa Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-300-2	Core Boxes	
Angle	-50	Cement	
Depth, End	341	Fondu	
Depth, Begin.	196	Grout Packer	Size
Drilled	145	Mech Packer	Size
Core Removed	145	Lost Circulation	
# of Runs		Other	

Soluble Oil ____
Drill Mud ____
Rod Lube ____

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10 HR	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2016/01	New	166		

REAMING SHELLS

BW44	05288	448			

Remarks (Explain Delays)

Driller HERMAN Helper OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY Job No. 21-2
Mine Project: Lamefoot Date: 9-24-97
Location: Republic WA Shift: Day ___ Swing ___ Grvyd X
Hole Size: HQ ___ NTW ___ NQ ___ B W44 A ___ Other ___

HOLE INFO

Hole # 28-300-2Y 1
Angle -50° / -35°
Depth, End 402' / 48'
Depth, Begin. 341 / -0-
Drilled 61' / 48
Core Removed 61 / 48
# of Runs ___

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 8
Reaming ___
Casing ___
Setup, Tear Down 1
Hole Conditioning 1 MAC. PACKER
Survey ___
Other (Specify) ½ come out LATE (truck in way)

Cementing ___
Equip. Repair ___
Delays by Client ___
Delays by Contractor ___
Blast Delay ___
Other Delay ___

BITS

Size	Serial No.	Previous Footage	On	Off	Total Footage
Bw44	7-2016/01	New	166	402	364
" "	" " "	364	0		

REAMING SHELLS

Bw44	05288	448	0	402	850
" "	" " "	850	0		

Remarks (Explain Delays) Sill To collar # 2 = 2 feet #1 = 3.5 feet. Kevin hurt finger midal of shift.

Driller M. LUTZ Helper K. dal bacon

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo BAY Job No. 21-2
Mine Project: LAME FOOT Date 9-25-97
Location: Republic Wa Shift: Day ✓ Swing ____ Grvyd ____
Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-300-1	Core Boxes	Soluble Oil
Angle	-35	Cement	Drill Mud
Depth, End	148	Fondu	Rod Lube
Depth, Begin.	48	Grout Packer	Size
Drilled	100	Mech Packer	Size
Core Removed	100	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____
Feet Cased ____ From ____ To ____ Size ____ C/S # ____
Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	6 HR	Cementing	
Reaming		Equip. Repair	3½ Remarks
Casing		Delays by Client	½ HR WAIT To get IN PORTAL
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2016/01	236	0		
REAMING SHELLS					
BW44	05288	850	0		

Remarks (Explain Delays) CHANGE slide shoes PUT New REAR PLATE & Roller ON Feed Boom CHANGE oil IN ROTATION WATER AT 70 FT IN Hole # 28-300-1
#2 WAS AT 80'
#3 WAS AT 80'

Driller HELLMAN Helper OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO-BAY Job No. 21-2

Mine Project: LAMEFOOT Date 9-25-97

Location Republic, WA. Shift: Day ____ Swing ____ Grvyd X

Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	28-300-1	Core Boxes	Soluble Oil
Angle	-35	Cement	Drill Mud
Depth, End	278'	Fondu	Rod Lube
Depth, Begin.	148	Grout Packer	Size
Drilled	130'	Mech Packer	Size
Core Removed	130'	Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	9	Cementing	
Reaming		Equip. Repair	1 hr
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2016-01	236	0	198	434
" "	7-2017-01	New	198		

BITS

REAMING SHELLS

BW44	05288	850	0		

Remarks (Explain Delays)

HAD TO CHAING CORE BARREL & HYDRO HOSE ON CHUCK BLEDOUT.

Driller LUTZ Helper DAL BALCON

Approved by Client [signature]

DYNAMIC DRILLING
DAILY REPORT

Client: Cedar Corp. Job No. 21-2

Mine Project: Lazarus Project Date: 7-25-22

Rig: Cedrex 45 Lat: 62 Hole Dip: Swing: Dyna X

Hole Size: HQ RW: HQ BQ/A Other:

HOLE INFO		SUPPLIES	
Hole #: 23-Zero-1		Core Boxes:	Sample Qty:
Azimuth: -72		Cement:	Drill Mud:
Depth, End: 23.78		Foam:	Rod Lube:
Core: Begin: 1.85		Grout Packer:	Size:
Drill: 1.70		Mech Packer:	Size:
Core Recovery: 1.70		Lab Consolidation:	
Fit of Hole:			
		Other:	

Fast Reamed: From: To:

Fast Cased: From: To: Size: CSG

Cleaner Drilled: From: To:

TIME CHARGES (Hours)			
Drilling: 0	Connecting:		
Reaming:	Equip. Repair: 1.50		
Cleaning:	Delays by Client:		
Core Tube Clean:	Delays by Contractor:		
Coring:	Road Delay:		
Survey:	Other Delay:		
Other Drilling:			

Size	Total No.	Previous Footage	On	Off	Total Footage
Survey	2	2.75	0	1.85	4.60
Core 11	2	2.75	1.85		

REAMING SHELLS

Survey	0.5	2.50	0	

Remarks (Lessons Learned): Core Frozen Core Frozen Core Frozen

DYNAMIC DRILLING

#2

SHIFT REPORT

Client: Echo BAY Job No. 21-2

Mine Project: LAMEFOOT Date 9-26-97

Location: Republic Na Shift: Day ✓ Swing ____ Grvyd ____

Hole Size: HQ ____ NTW ____ NQ ____ BW44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #	08-300-1	Core Boxes	Soluble Oil
Angle	-35	Cement	Drill Mud
Depth, End	366	Fondu	Rod Lube
Depth, Begin.	278	Grout Packer	Size
Drilled	88	Mech Packer	Size
Core Removed	88	Lost Circulation	
# of Runs		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	6½ Hr	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Setup, Tear Down		Delays by Contractor	
Conditioning		Blast Delay	
Survey	3½ Hr Remarks	Other Delay	

Other (Specify) 1 Hr Supplys

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW44	7-2017/01	New BITS	198		
		REAMING SHELLS			
BW44	05288	850	0		

Remarks (Explain Delays) Survey Hole #1 Setup on & Renter #2 + survey and set back and Renter #1

Driller Hellman Helper Osler

Approved by Client RW Lee

DYNAMIC DRILLING
SHIFT REPORT

Client: ECHO BAY — Job No. 21
Project: LAME FOOT — Date 12-3-97
Location — Shift: Day ✓ Swing ___ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ B W-44 A ___ Other ___

HOLE INFO		SUPPLIES			
Hole #	Z8-300-5	Core Boxes		Soluble Oil	
Angle	-43°	Cement		Drill Mud	
Depth, End	363	Fondu		Rod Lube	
Depth, Begin.	223	Grout Packer		Size	
Drilled	140	Mech Packer		Size	
Core Removed	140	Lost Circulation			
# of Runs					
		Other			

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	8 1/2	Cementing	
Reaming		Equip. Repair	1-CHANGE CHUCK SAWS
Casing		Delays by Client	1/2-NO POWER
Set Up, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BW-44	7-2470-1	NEW	122	363	241T
BW-44	7-2548-2	NEW	363		

BITS

REAMING SHELLS

BW-44	P-1270	5960	0		

Remarks (Explain Delays) HOLE IS MAKING APROX. 4 GPM OF WATER AT ~250'

Driller K. DECKER — Helper J. OSLER

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 21
Mine Project: Lomefoot Date 12-1-97
Location 2225 Shift: Day ✗ Swing ✓ Grvyd
Hole Size: HQ ___ NTW ___ NQ ___ BQ-44A ___ Other ___

HOLE INFO		SUPPLIES	
Hole #	28-300-4	Core Boxes	Soluble Oil
Angle	-25°	Cement	Drill Mud
Depth, End	228	Fondu	Rod Lube
Depth, Begin.	0	Grout Packer	Size
Drilled	228	Mech Packer	Size
Core Removed	228	Lost Circulation	
# of Runs		Other	10.1 Gal Diesel

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling	7	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Set-up, Tear Down	3 - Finish Move	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BQ-44	7-2211-12	270'	0		
~~NQ~~					
REAMING SHELLS					
BQ-44	P-1270	5586'	0		

Remarks (Explain Delays) #300-4 is 4' from collar to sill. Not making any water

Driller Chris Helper K. Dalbalcom

Approved by Client [signature]

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Energy — Job No. 24
Contractor: Lobstone — Date: 12-1-92
Location: 3367 — Date Out: 2 — Spudding: Yes — Drilled
Contractor No. ____ RTW ____ No. ____ B.O. N/A ____ Other ____

MOVE INFO		SUPPLIES	
Rig #	30-30-1	Core Boxes	Service Oil
Mast	3-65	Casings	Oil Mud
Mast Out	2363	Fondu	Rod Lube
Mast Begin	0	Donut Fodder	Rice
Mast	2363	Mesh Feeder	Sawdust
Rig Released	2363	Lost Circulation	
Rig # from			
		Other	15 1 Mast Mast

Mast Raised ____ From ____ To ____
Mast Lowered ____ From ____ To ____ Sun ____ Cold
Drilling Delayed ____ From ____ To ____

TIME CHARGES (Hours)

Drilling ____ 7 — Connecting ____
Tripping ____ — Equip. Repair ____
Time Down 3 — Mast Move — Delays by Client ____
Delays by Contractor ____
Circulating ____ — Bits Delay ____
Survey ____ — Other Delay ____
Wait (Specify) ____

Size	Bit No.	Serial Number	Footage	On	Off	Total Footage
7 7/8	1-12	210	BITS			

REAMING SHELLS

7 7/8	0-120	5556	12		

Remarks (Special Design) 4½ 3½ Ins 1 from Cellar
Pipe 5111. Wait - Mast Mud Dirty on Site

Driller: Clay — Name: K. Dorfelson
Received by Client: ____

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO BAY Job No. 12-2-97

Project: LAMEFOOT Date JOB#21

Location _____ Shift: Day ✓ Swing ____ Grvyd ____

Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		SUPPLIES			
Hole #	28-300-4	Core Boxes		Soluble Oil	
Angle	-25°	Cement		Drill Mud	
Depth, End	357	Fondu		Rod Lube	
Depth, Begin.	228	Grout Packer		Size	
Drilled	129	Mech Packer		Size	
Core Removed	129	Lost Circulation			
# of Runs					
		Other			

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling	10	Cementing	
Reaming		Equip. Repair	
Casing		Delays by Client	
Set-up, Tear Down		Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	
Other (Specify)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
BW-44	7-22-11-12	270	0	268	538T
" "	593971	NEW	268	337	69T
" "	7-2548-1	NEW	268	268	0T
				LOST CROWN OF BIT	
REAMING SHELLS					
BW-44	BIT 7-2212-9	NEW	337		
BW-44	P-1270	5586	0		

Remarks (Explain Delays) HOLE NOT MAKING ANY WATER AT 357'

K. DECKER Helper J. OSLER

Approved by Client RW Lee

DYNAMIC DRILLING
DAILY REPORT

Owner _____ Job No. _____

Well _____ Date _____

Contractor _____ Rig No. _____

Drill Pipe No. _____ O.D. _____ Size _____ Grade _____

Drill Collars No. _____ O.D. _____ Size _____ Grade _____

HOLE INFO	SUPPLIES
Hole # _____	Core Barrels _____ Fuel _____
Depth _____	Cement _____ Drill Mud _____
Depth Cor. _____	Fuel _____ Fuel Lube _____
Depth Start _____	Mud Pump _____ Size _____
Depth _____	Mud Pump _____ Size _____
Core Diameter _____	Last Circulation _____
# of Runs _____	
	Other _____

Last Reamed _____ From _____ To _____

Last Cored _____ From _____ To _____ Size _____ Core # _____

Last Drilled _____ From _____ To _____

TIME CHARGES (Hours)

Drilling	10	Cement	
Reaming		Equip. Repair	
Coring		Delays by Client	
Trip Drill		Delays by Contractor	
Trip Coring		Blast Delay	
Survey		Other Delay	
Other (Check)			

Size	Serial No.	Previous Footage	On	Off	Total Footage
Bit W	22-42	222	0	246	5317
	3271	4061	265	332	6327
	2-2-4	6681	265	265	0.7

BIT FRAMING SHEET

Bit W	22-42	4061	2272
Bit W	8-4228	2594	0

Remarks (Include Delays) Hole not finished due to [illegible]

Helper _____

Approved by Client _____

DYNAMIC DRILLING
SHIFT REPORT

Client: Echo Bay Job No. 21
M[illegible] Project: Lamefoot Date 12-2-97
Location 2225 Shift: Day ___ Swing ✓ Grvyd ___
Hole Size: HQ ___ NTW ___ NQ ___ BW44 A ___ Other ___

HOLE INFO		
Hole #	28-300-4	300-5
Angle	-25°	-43'
Depth, End	374	223
Depth, Begin.	357	0
Drilled	17	223
Core Removed	17	223
# of Runs		

SUPPLIES

Core Boxes ___ Soluble Oil ___
Cement ___ Drill Mud ___
Fondu ___ Rod Lube ___
Grout Packer ___ Size ___
Mech Packer ___ Size ___
Lost Circulation ___
Other ___

Feet Reamed ___ From ___ To ___
Feet Cased ___ From ___ To ___ Size ___ C/S # ___
Cement Drilled ___ From ___ To ___

TIME CHARGES (Hours)

Drilling 9 Cementing ___
Reaming ___ Equip. Repair ___
Casing ___ Delays by Client ___
S[illegible] Tear Down 1- Delays by Contractor ___
Hole Conditioning ___ Blast Delay ___
Survey ___ Other Delay ___
Other (Specify) ___

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
3W-44	7-2212-9	New	337'	374	37'
	"	37'	0	122'	159' T
	7-2470-1	~~12~~ New'	122'		
REAMING SHELLS					
3W-44	9-1270	5586	0	374	5960'
	"	5960'	0		

Remarks (Explain Delays) #300-4 Not making any water, #300-5 Not making any. 2' From Collar to Sill.

D[illegible] C. Jess Helper K. Dal Balcom

Approved by Client RW L[illegible]

DYNAMIC DRILLING
SHIFT REPORT

Client ECHO BAY Job No. 21

Project: LAMEFOOT Date 12-1-97

Location _____ Shift: Day ✓ Swing ____ Grvyd ____

Hole Size: HQ ____ NTW ____ NQ ____ BW-44 A ____ Other ____

HOLE INFO		SUPPLIES	
Hole #		Core Boxes	Soluble Oil
Angle		Cement	Drill Mud
Depth, End		Fondu	Rod Lube
Depth, Begin.		Grout Packer	Size
Drilled		Mech Packer	Size
Core Removed		Lost Circulation	
# of Runs			
		Other	

Feet Reamed ____ From ____ To ____

Feet Cased ____ From ____ To ____ Size ____ C/S # ____

Cement Drilled ____ From ____ To ____

TIME CHARGES (Hours)

Drilling		Cementing	
Reaming		Equip. Repair	
Coring		Delays by Client	1/2-NO POWER
Setup, Tear Down	7 1/2	Delays by Contractor	
Hole Conditioning		Blast Delay	
Survey		Other Delay	

Other (Specify) 2- BLOWING DRAIN LINE OUT + SETTING PUMP TO PUMP

Size	Serial No.	Previous Footage	On	Off	Total Footage
BITS					
REAMING SHELLS					

Remarks (Explain Delays) SETTING PUMP SO WE COULD GET AS MUCH MUD PUMPED OUT OF BOTTOM TO BUILD DECK. - 2HR.

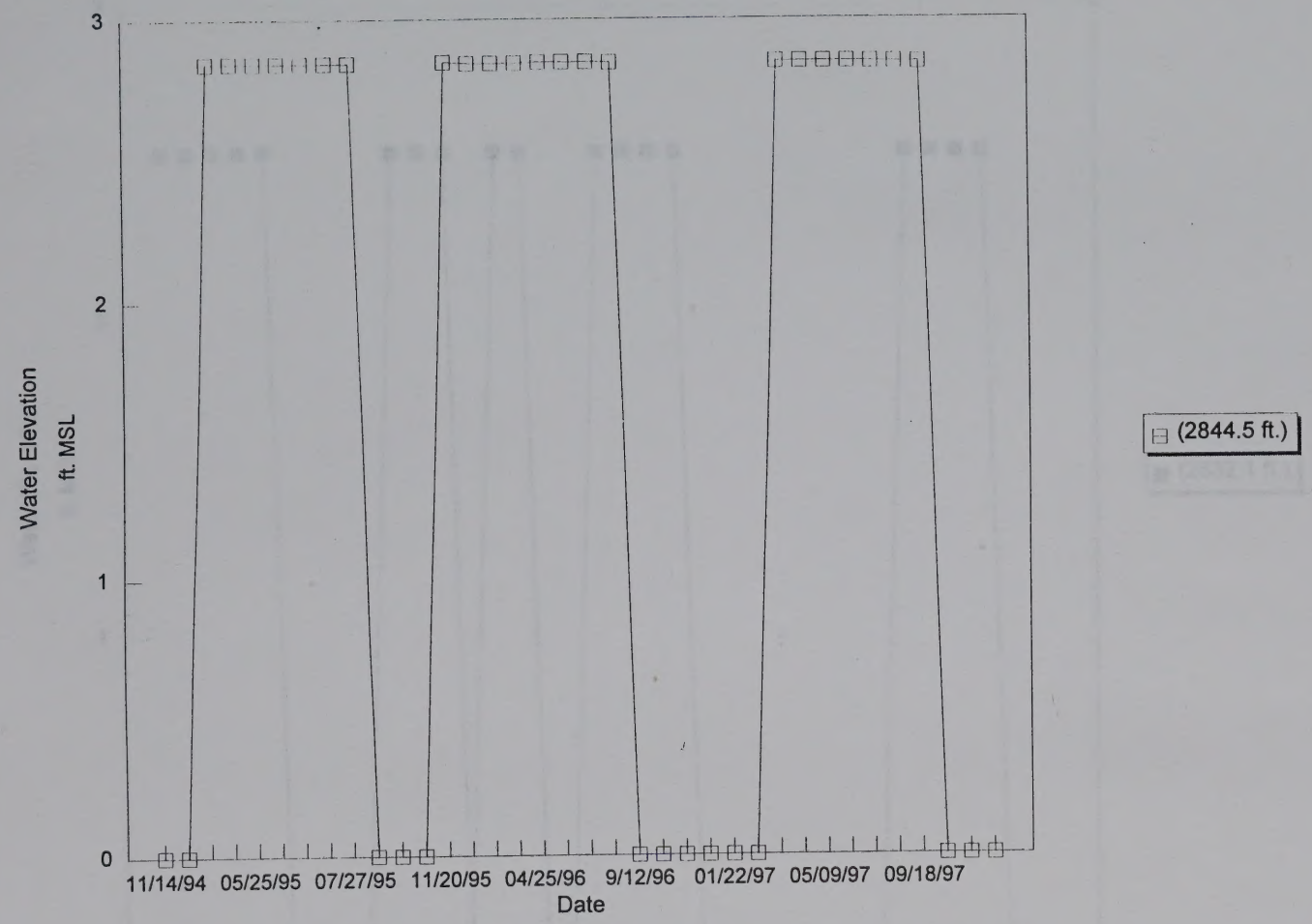
Driller K. DECKER Helper J. OSLER

Approved by Client [signature]

APPENDIX B

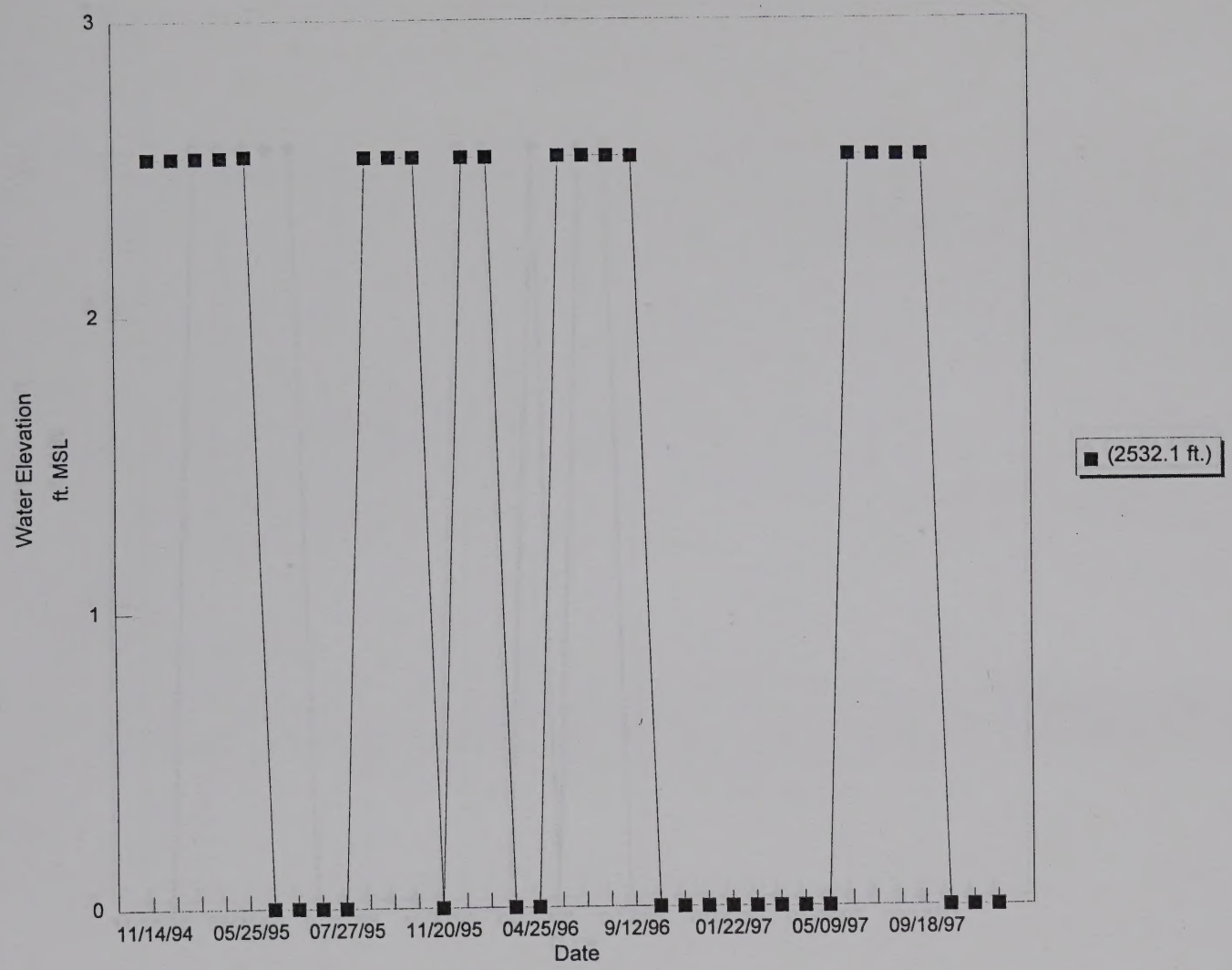
MONITORING DATA SUMMARY GRAPHS

Wetland Water Elevations



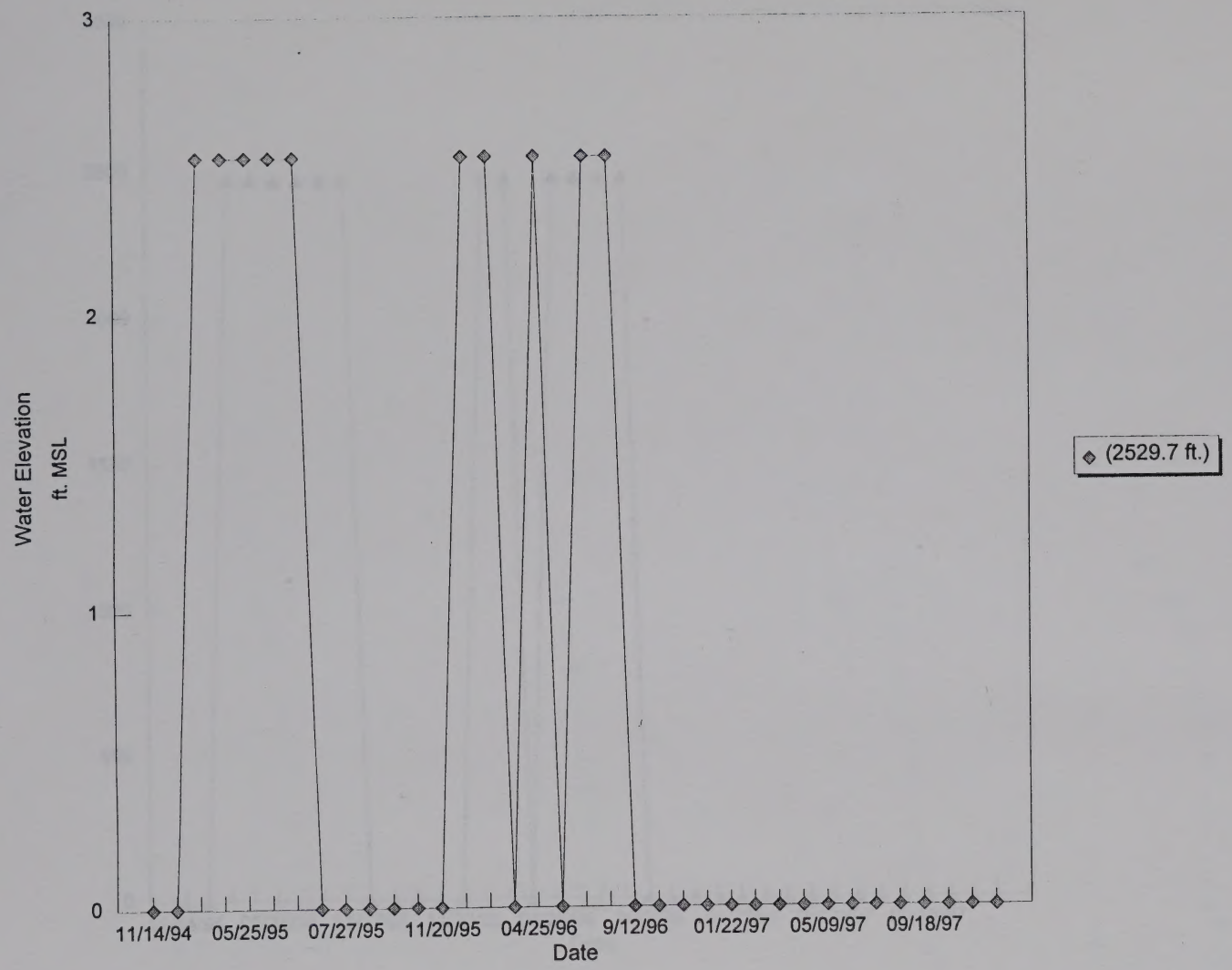
Date	Sta. #1 (2844.5 ft.)
11/14/94	DRY
11/23/94	DRY
02/07/95	2845.2
02/24/95	2846.6
05/25/95	2845.9
06/29/95	2845.9
07/13/95	2845.5
07/21/95	2845.2
07/27/95	2845.1
08/29/95	DRY
09/07/95	DRY
10/23/95	DRY
11/20/95	2850.0
01/17/96	2844.5
03/08/96	2844.5
03/28/96	2844.5
04/25/96	2847.5
05/09/96	2847.5
07/08/96	2847.0
08/14/96	2845.0
9/12/96	DRY
10/30/96	DRY
11/26/96	DRY
12/04/96	DRY
01/22/97	DRY
02/25/97	DRY
03/26/97	2847.7
04/25/97	2847.69
05/09/97	2847.59
06/27/97	2846.96
07/21/97	2846.52
08/14/97	2845.46
09/18/97	2844.58
10/29/97	DRY
11/10/97	DRY
12/02/97	DRY

Wetland Water Elevations



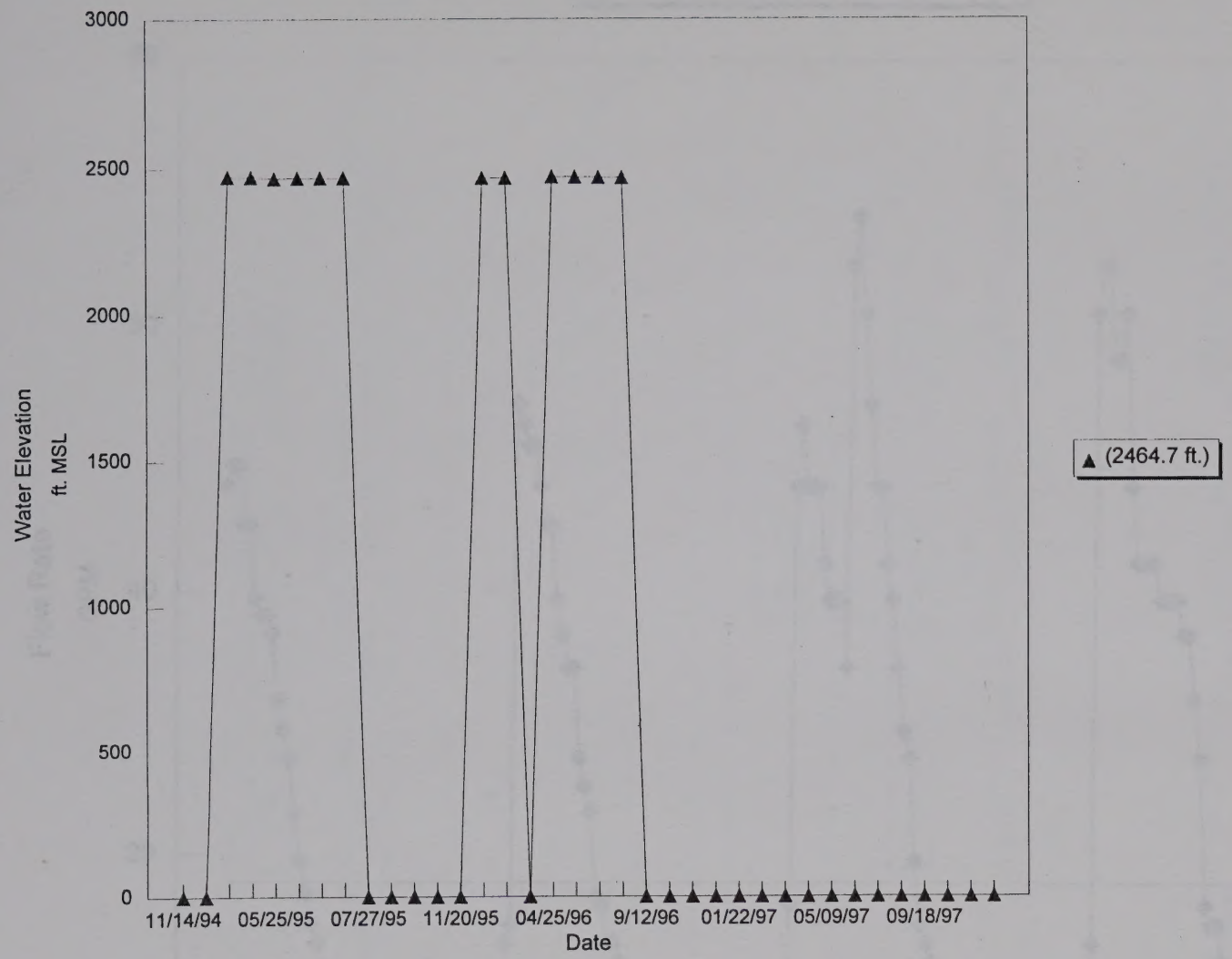
Date	Sta. #2 (2532.1 ft.)
11/14/94	2533.0
11/23/94	2533.0
02/07/95	2533.7
02/24/95	2534.2
05/25/95	2539.3
06/29/95	NA
07/13/95	NA
07/21/95	NA
07/27/95	NA
08/29/95	2533.4
09/07/95	2533.4
10/23/95	2533.0
11/20/95	2532.1
01/17/96	2532.1
03/08/96	2532.1
03/28/96	N/A
04/25/96	N/A
05/09/96	2535.9
07/08/96	2535.5
08/14/96	2534.0
9/12/96	2533.5
10/30/96	Below Gauge
11/26/96	Frozen
12/04/96	Frozen
01/22/97	Frozen
02/25/97	Frozen
03/26/97	Above Gauge
04/25/97	Above Gauge
05/09/97	Above Gauge
06/27/97	2535.96
07/21/97	2534.68
08/14/97	2533.91
09/18/97	2533.69
10/29/97	Below Gauge
11/10/97	Below Gauge
12/02/97	Frozen

Wetland Water Elevations



Date	Sta. #3 (2529.7 ft.)
11/14/94	DRY
11/23/94	DRY
02/07/95	2530.0
02/24/95	2529.7
05/25/95	2529.7
06/29/95	2529.7
07/13/95	2529.7
07/21/95	DRY
07/27/95	DRY
08/29/95	DRY
09/07/95	DRY
10/23/95	DRY
11/20/95	2529.7
01/17/96	2529.7
03/08/96	2529.7
03/28/96	N/A
04/25/96	2529.7
05/09/96	NA
07/08/96	2529.7
08/14/96	2529.7
9/12/96	DRY
10/30/96	DRY
11/26/96	DRY
12/04/96	DRY
01/22/97	DRY
02/25/97	DRY
03/26/97	Below Gauge
04/25/97	Below Gauge
05/09/97	Below Gauge
06/27/97	Below Gauge
07/21/97	Below Gauge
08/14/97	DRY
09/18/97	DRY
10/29/97	DRY
11/10/97	DRY
12/02/97	DRY

Wetland Water Elevations



Date	Sta. #4 (2464.7 ft.)
11/14/94	DRY
11/23/94	DRY
02/07/95	2471.0
02/24/95	2469.6
05/25/95	2464.9
06/29/95	2466.9
07/13/95	2466.6
07/21/95	2466.4
07/27/95	DRY
08/29/95	DRY
09/07/95	DRY
10/23/95	DRY
11/20/95	2464.7
01/17/96	2464.7
03/08/96	2464.7
03/28/96	N/A
04/25/96	2468.1
05/09/96	2467.9
07/08/96	2467.0
08/14/96	2466.0
9/12/96	Vegetation blocking gauge
10/30/96	Vegetation blocking gauge
11/26/96	Frozen
12/04/96	Frozen
01/22/97	Frozen
02/25/97	Frozen
03/26/97	Vegetation blocking gauge
04/25/97	Vegetation blocking gauge
05/09/97	Vegetation blocking gauge
06/27/97	Vegetation blocking gauge
07/21/97	Vegetation blocking gauge
08/14/97	Vegetation blocking gauge
09/18/97	Vegetation blocking gauge
10/29/97	Vegetation blocking gauge
11/10/97	Vegetation blocking gauge
12/02/97	Frozen

Wolf Camp Spring

Historic Flow

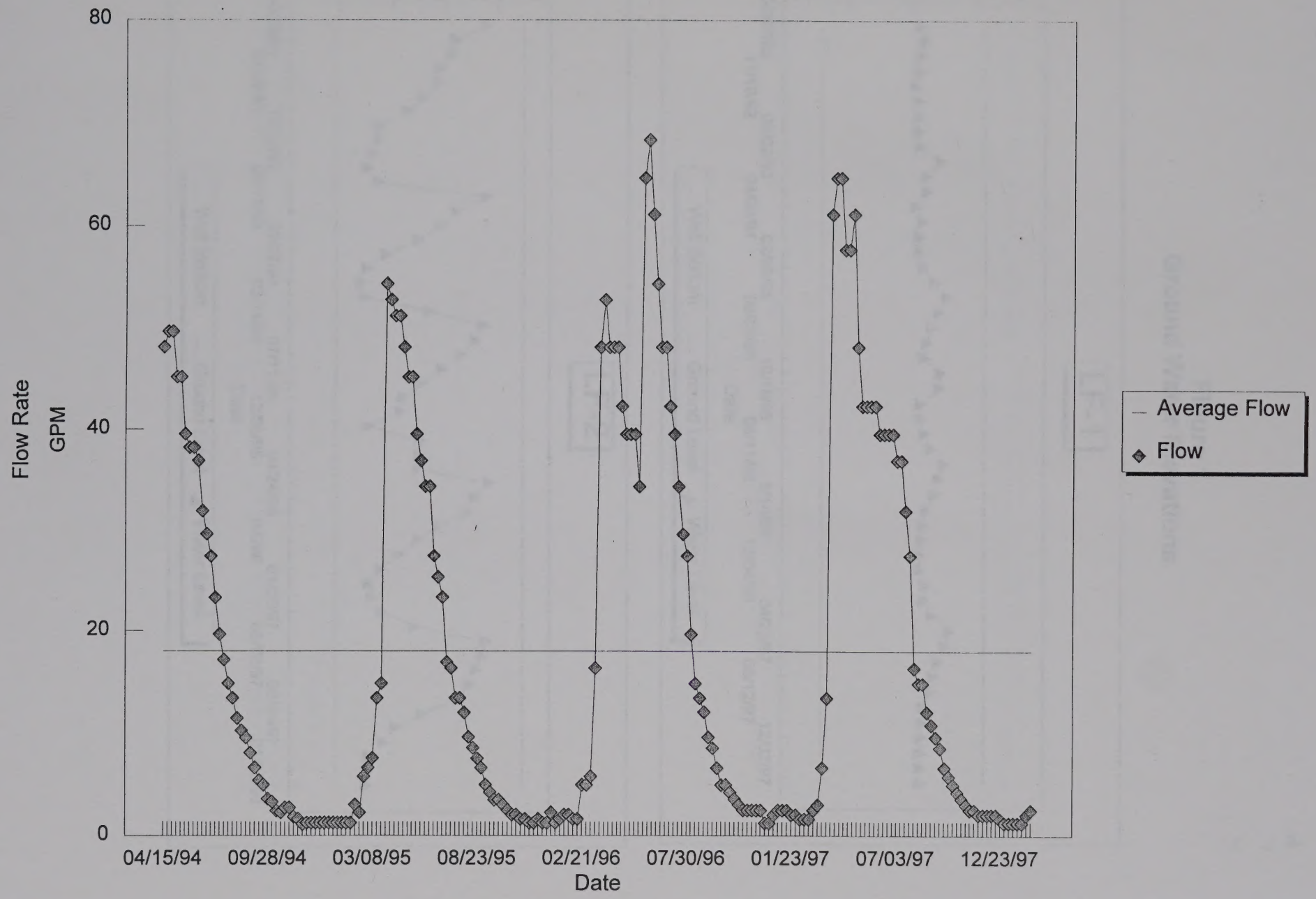
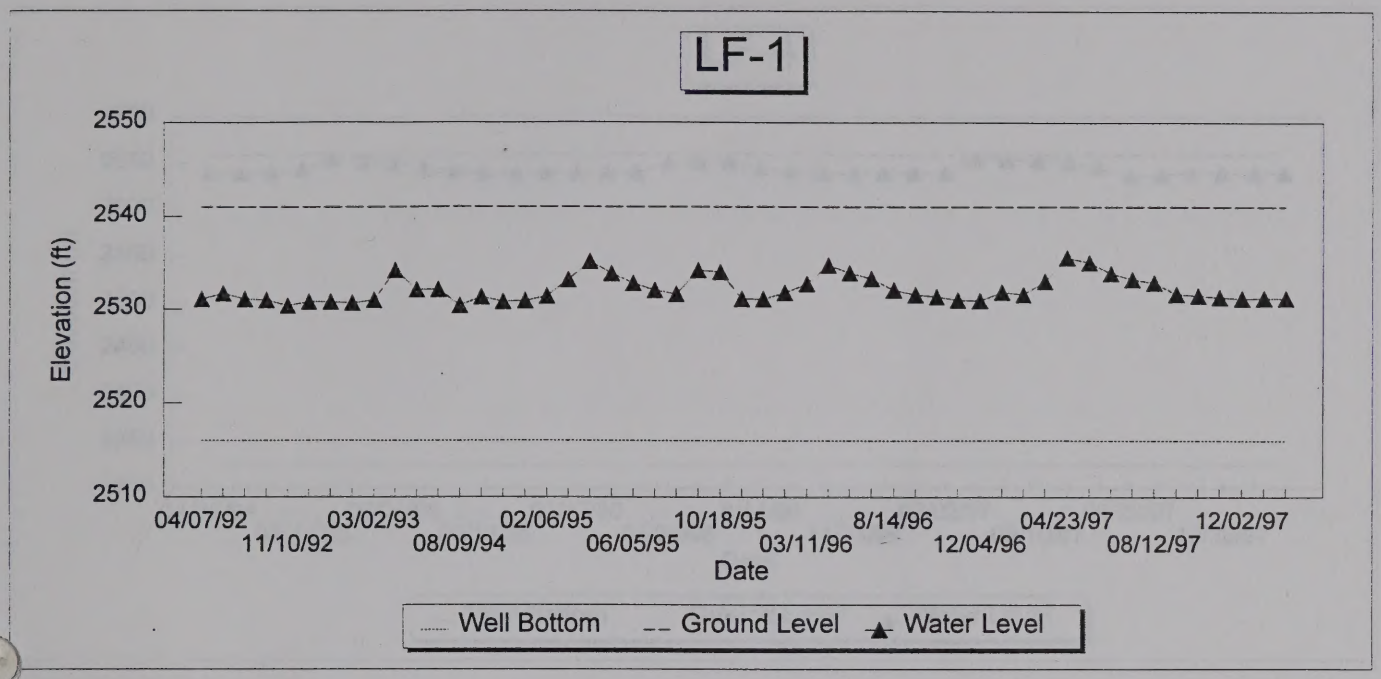


Figure 1
Ground Water Elevations



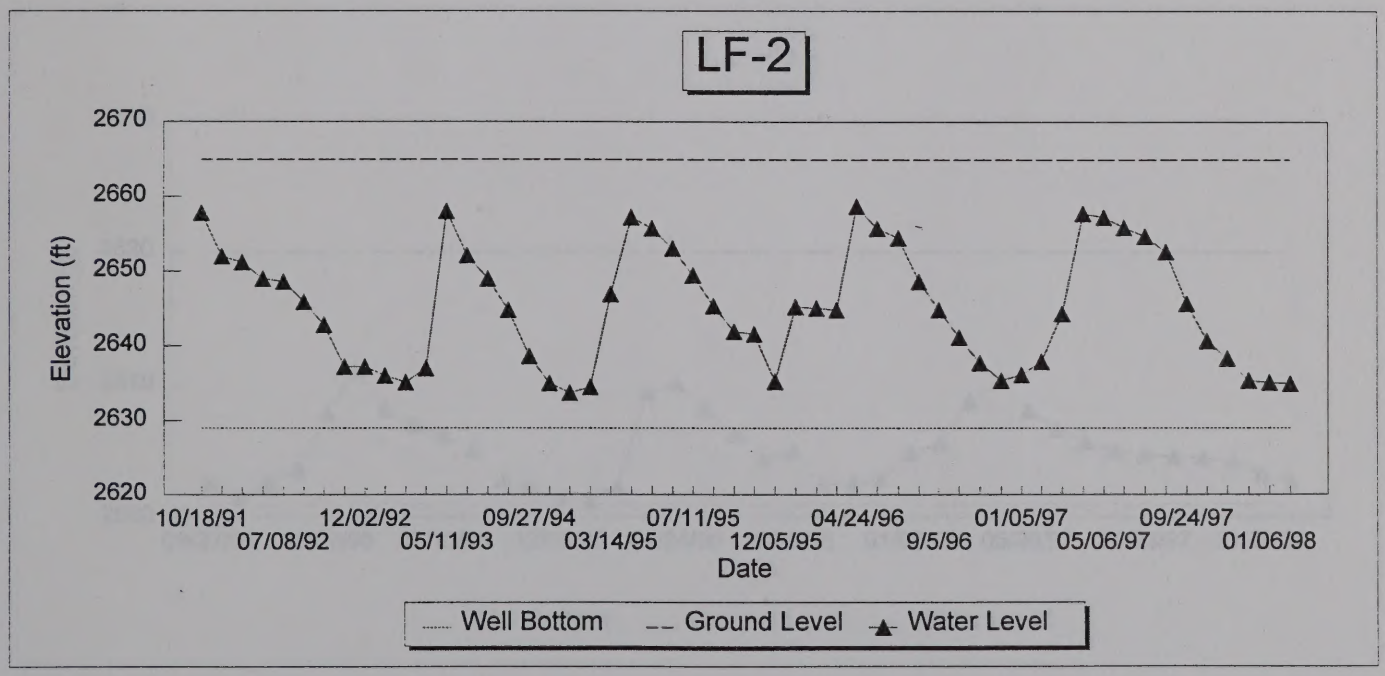
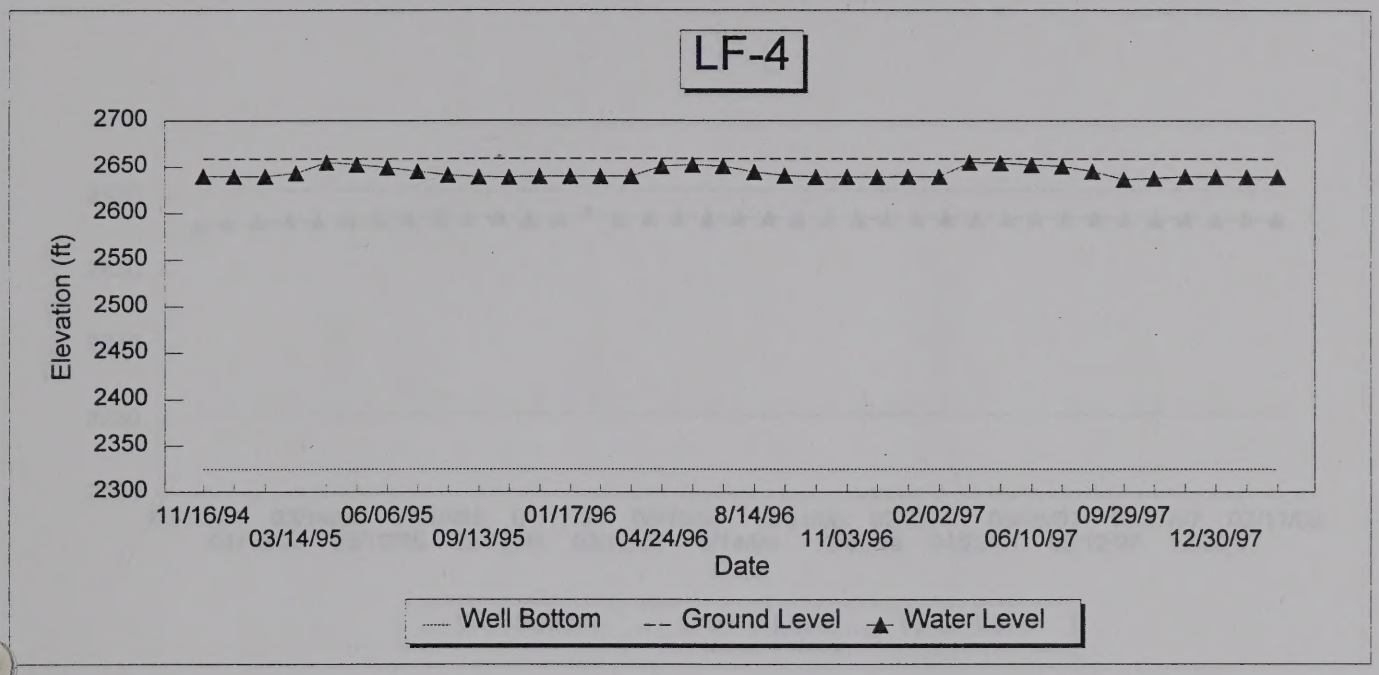


Figure 2
Ground Water Elevations



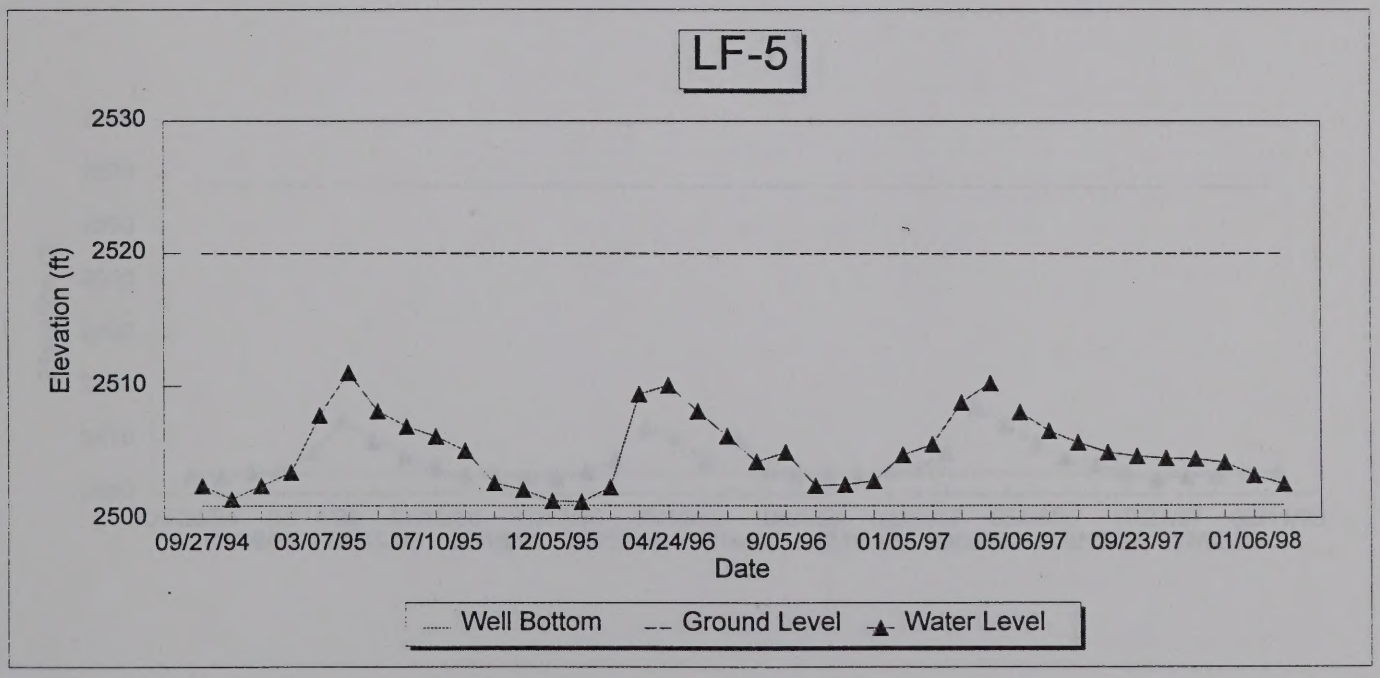
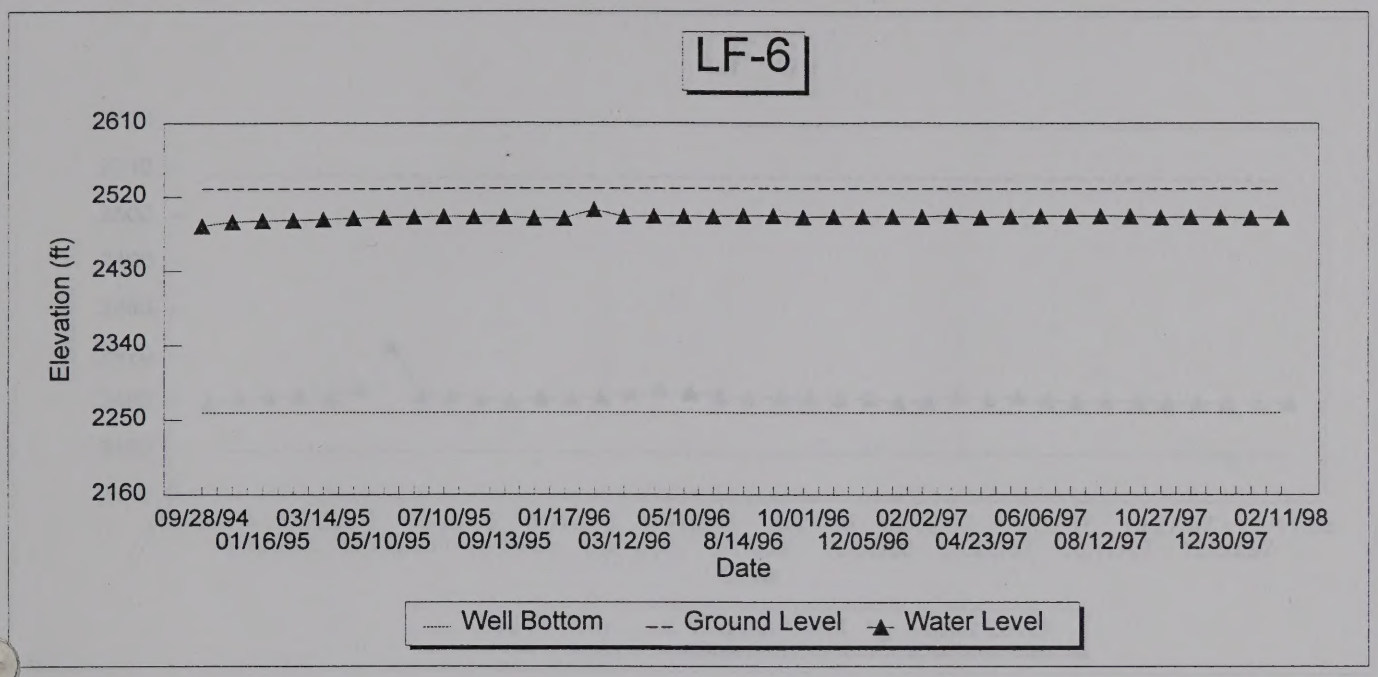


Figure 3
Ground Water Elevations



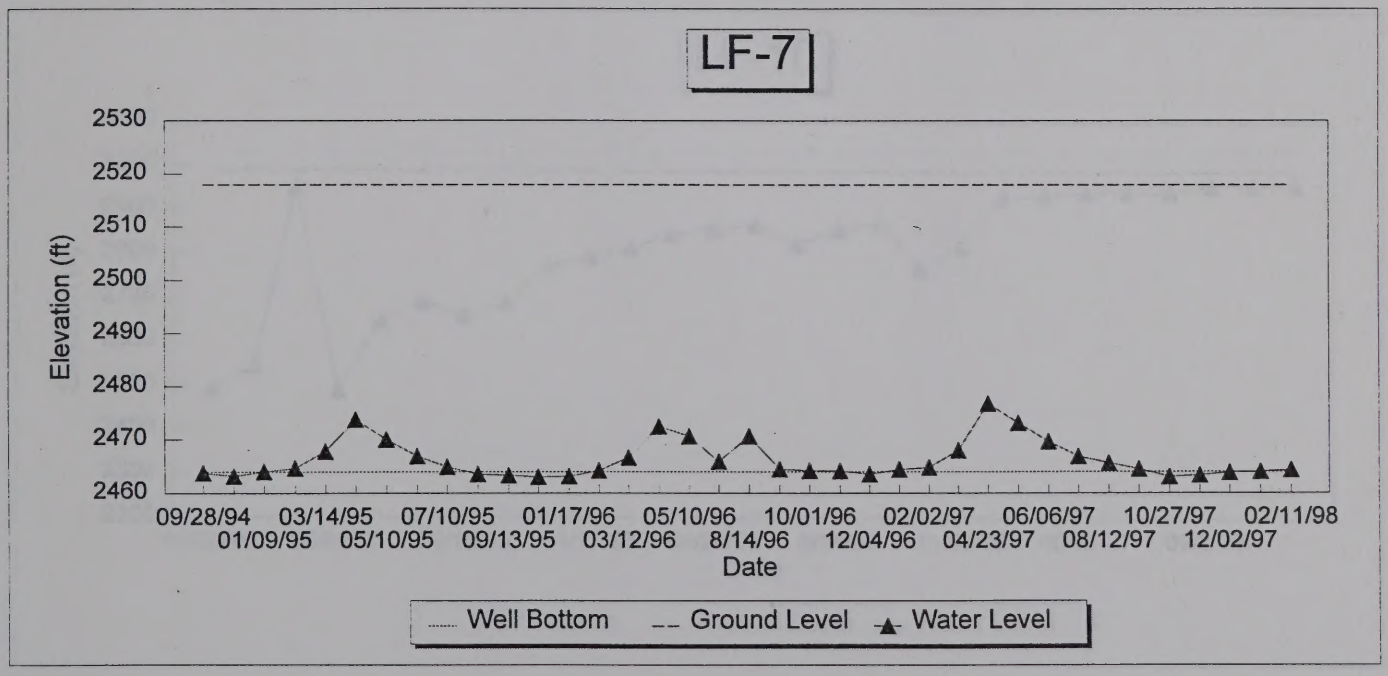
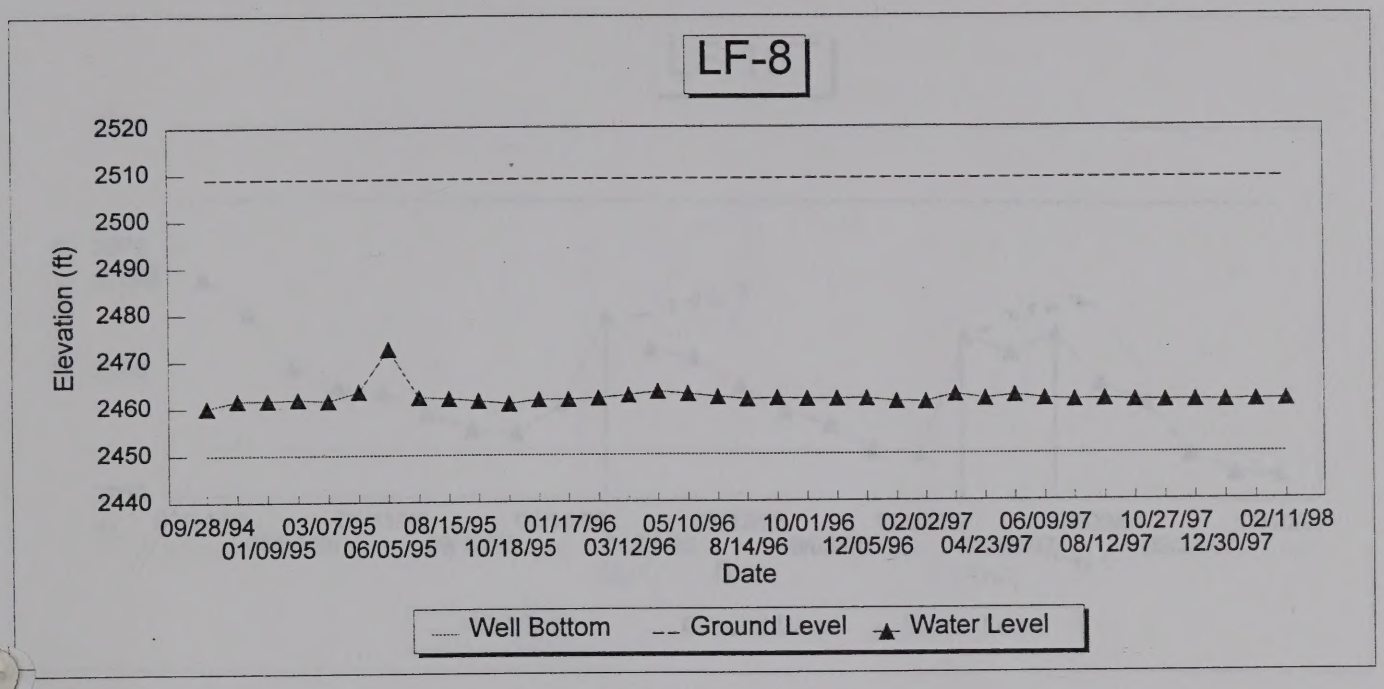


Figure 4
Ground Water Elevations



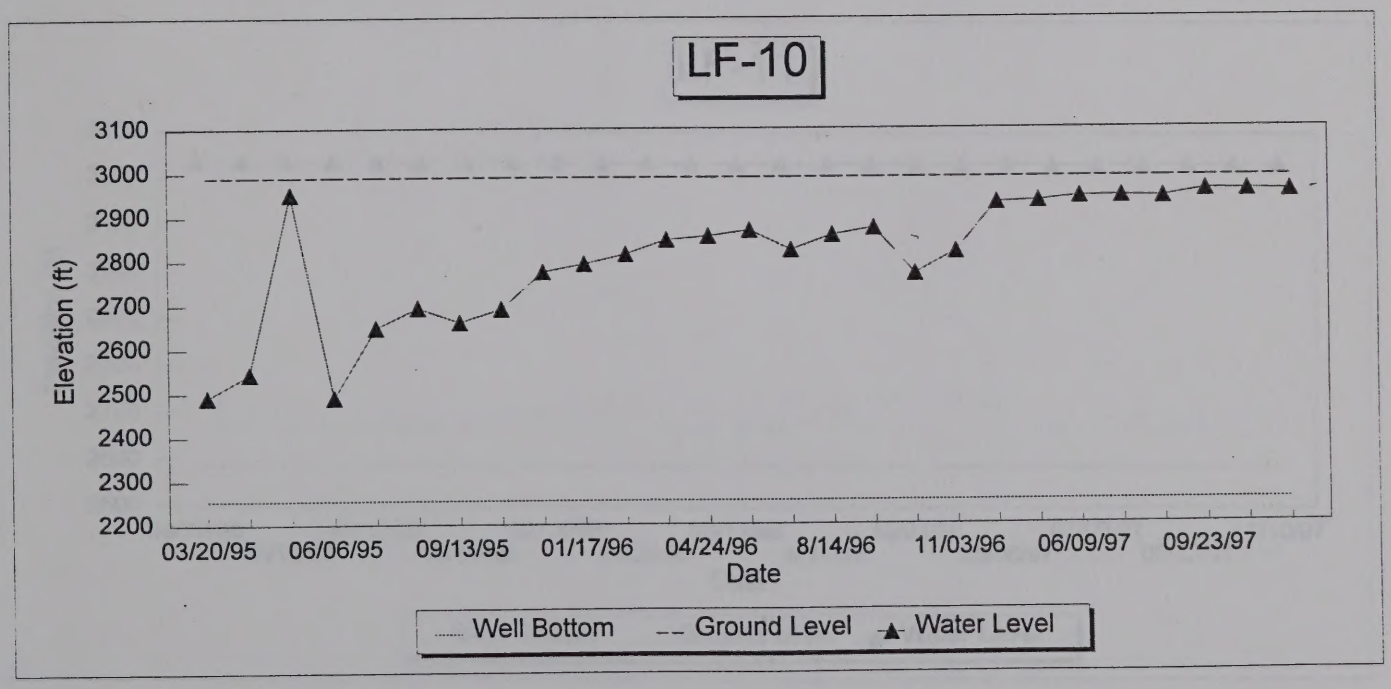
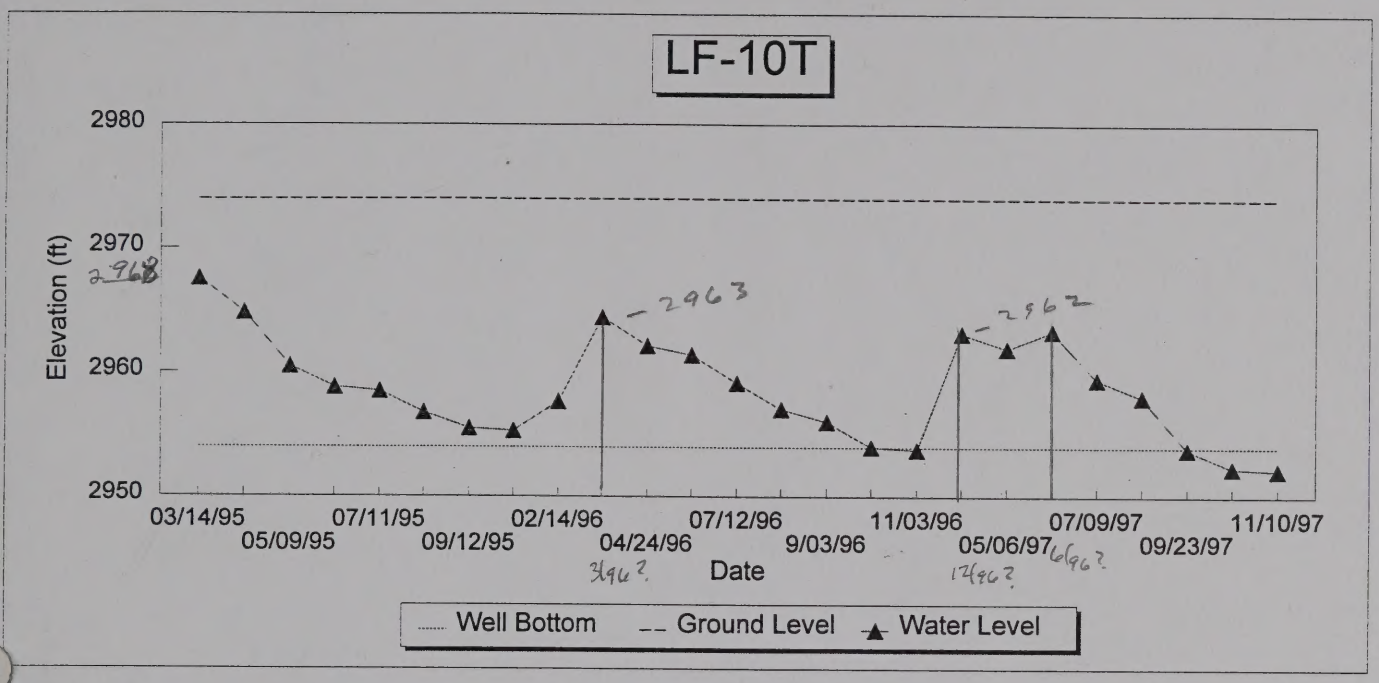


Figure 5
Ground Water Elevations



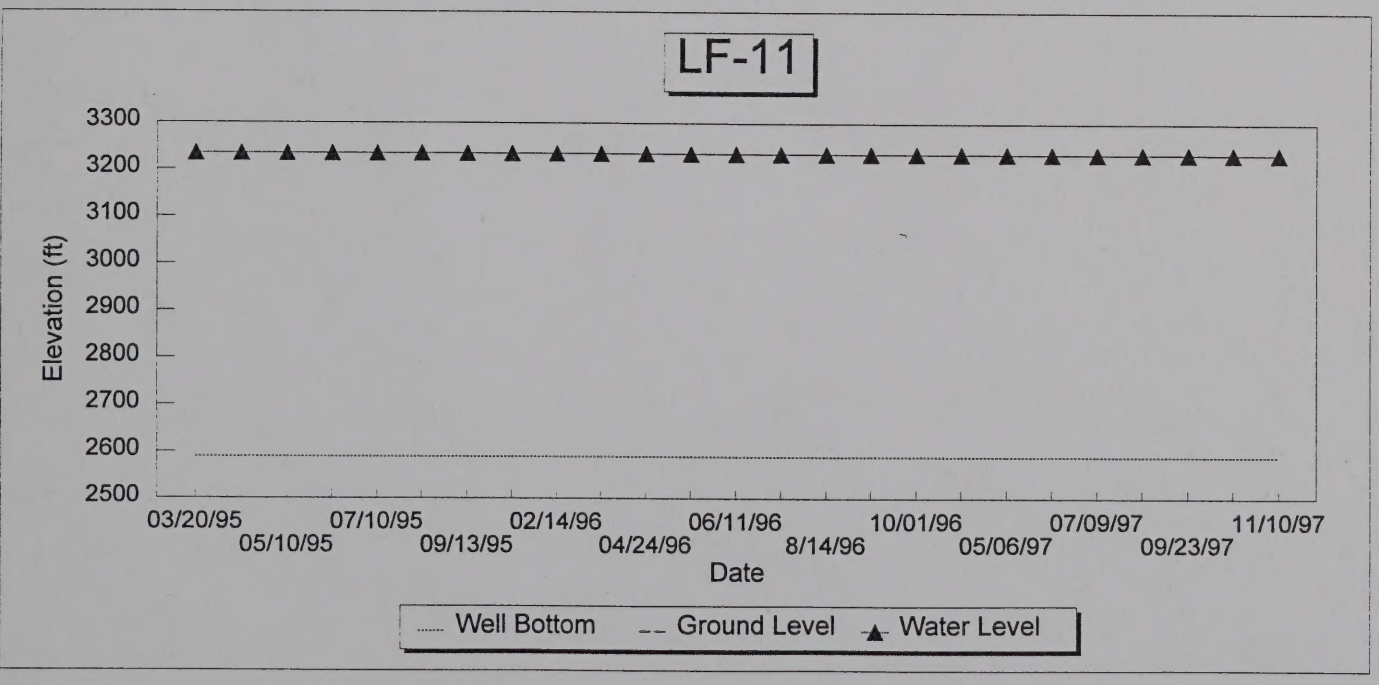
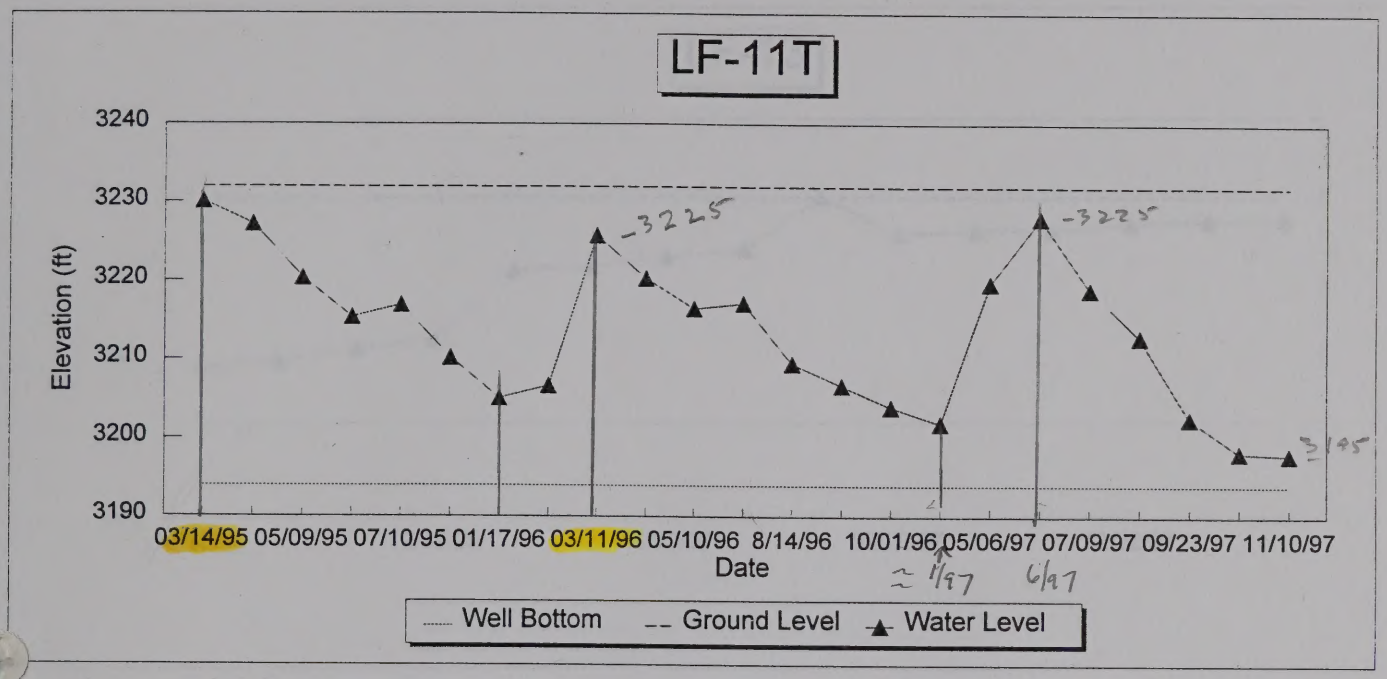


Figure 6
Ground Water Elevations



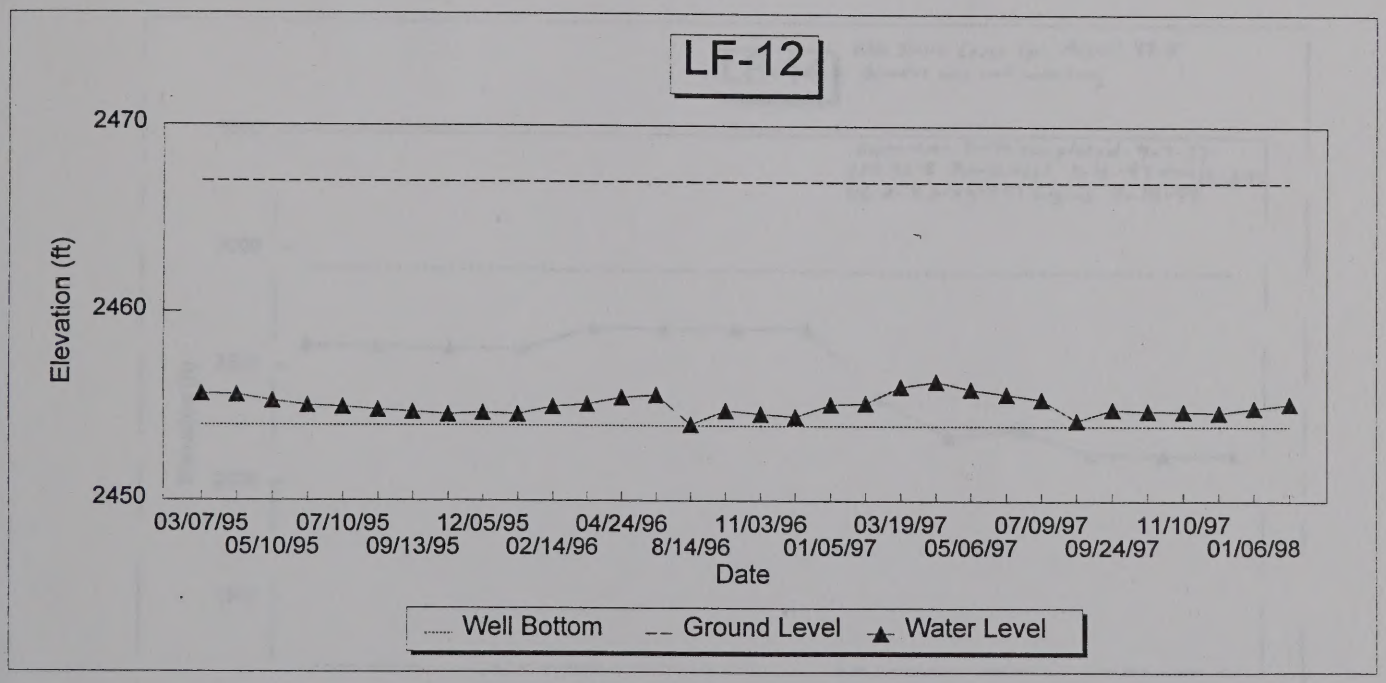
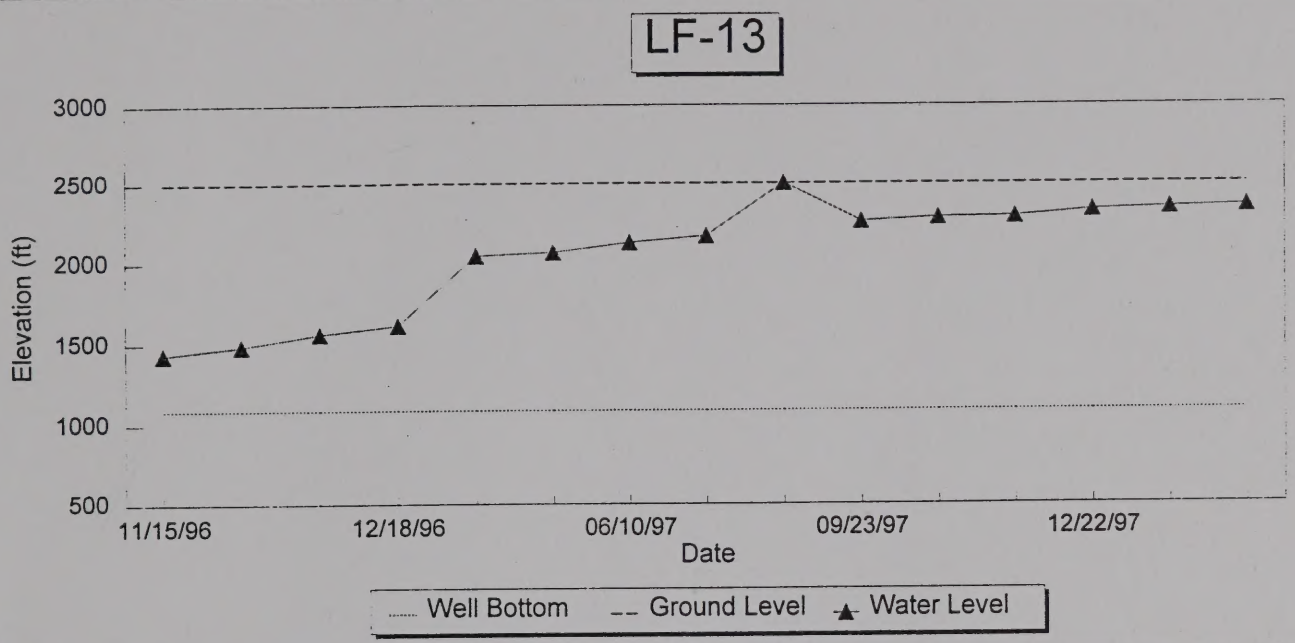
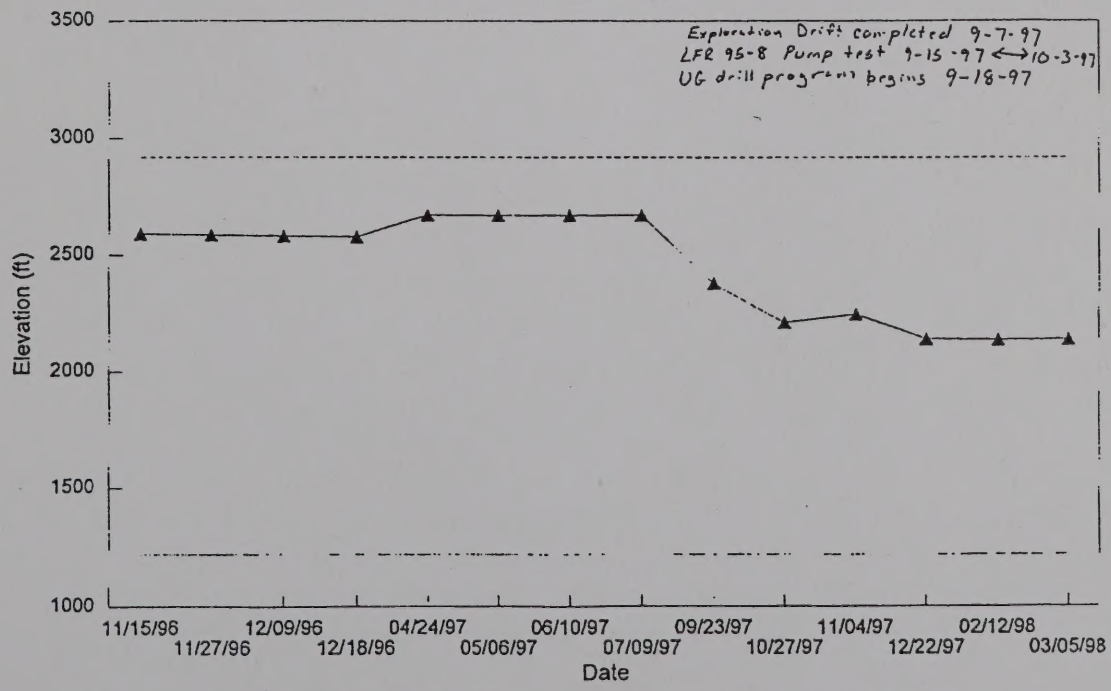


Figure 7
Ground Water Elevations





APPENDIX
B

APPENDIX
C

Appendix C

Geochemical PHREEQC Modeling

C 1 – Model Input

C 2 – Model Output

C1 – Model Input

```
#legend wr=wall rock
SELECTED_OUTPUT
        -file short.out
        -totals F Cl N(5) N(3) C(4) S(6) Na K Cu(1) Ag Ca Mg Ba Cd Cu(2) Pb Ni Zn Fe(2) Mn(2) Al
Fe(3) Mn(3) As(3) As(5)
        -equilibrium_phases Calcite Pyrite CO2(g) Alunite Gypsum Barite Siderite Boehmite
Brochantite Jarosite-K Al4(OH)10SO4 Antlerite Al(OH)3(a) Malachite Ferrihydrite Azurite Anglesite
Otavite Smithsonite ZnCO3:H2O Ca3(AsO4)2:6H2O
        -molalities Hfo_sOCu+ Hfo_sOZn+ Hfo_sOHAsO4-3 Hfo_sAsO4-2 Hfo_sHAsO4- Hfo_sH2AsO4
Hfo_sH2AsO3 Hfo_wOCu+ Hfo_wOZn+ Hfo_wOHAsO4-3 Hfo_wAsO4-2 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
        END
TITLE WR-1
SOLUTION 1      WR-1  Massive Unaltered Limestone, no sulfide
Units   mg/l
C               .18000E+02 gfw 50.04460
F               .22000E+00
N(5) N(3)        .67340E+02
K               .10000E+01
Na              .20000E+01   Charge
Ca              .19100E+03
Mg              .94000E+02
S(6)            .70400E+03
Cl              .10000E+01
Al              .10000E+00
As(5) As(3)           .95000E-02
Ba              .10000E+00
Cd              .10000E-02
Cu(2) Cu(1)                   .10000E-01
Fe(2) Fe(3)   .30000E-01
Pb              .10000E-01
Mn(2) Mn(3)   .10000E-01
Ni              .10000E-01
Si              .20500E+01 as H4SiO4
Ag              .50000E-02
Zn              .10000E-01
Temp            10.00
pH              8.4
pe              3.5599
PRINT
        -reset false
END
TITLE WR-2
SOLUTION 2 WR-2  Massive Magnetite with calcite veining , low sulfides
Units mg/L
C       .21000E+02 gfw 50.04460
F       .12000E+00
N(5) N(3)   .25300E+02
K       .10000E+01
Na      .10000E+01  Charge
Ca      .76000E+02
Mg      .10000E+02
S(6)    .15700E+03
Cl      .10000E+01
Al      .30000E+00
As(5) As(3)   .95000E-02
Ba      .10000E+00
Cd      .10000E-02
Cu(2) Cu(1) .10000E-01
Fe(2) Fe(3)     .30000E-01
Pb      .10000E-01
Mn(3) Mn(2) .10000E-01
Ni      .10000E-01
Si      .34220E+01 as H4SiO4
Ag      .50000E-02
Zn      .20000E-01
pH      8.1
pe      3.5599
Temp    10.0
PRINT
        -reset  false
END
```

```
TITLE WR-3
SOLUTION 3      WR-3  Massive sulfide and magnetite
Units mg/L
C       .31000E+02 gfw 50.04460
F       .12000E+00
N(5) N(3)    .10145E+03
K       .11000E+02
Na      .11000E+02   Charge
Ca      .19000E+03
Mg      .23500E+03
S(6)    .14300E+04
Cl      .20000E+01
Al      .10000E+00
As(5) As(3)   .95000E-02
Ba      .10000E+00
Cd      .27000E-01
Cu(2) Cu(1) .10000E-01
Fe(2) Fe(3)     .18000E+00
Pb      .10000E-01
Mn(2) Mn(3)     .43600E+01
Ni      .10000E-01
Si      .30800E+01 as H4SiO4
Ag      .50000E-02
Zn      .12200E+02
pH      6.8
pe      3.5599
Temp    10.0
PRINT
        -reset  false
END
TITLE WR-4
SOLUTION 4 WR4  Clastic with high S content
Units mg/L
C       .20000E+01 gfw 50.04460
F       .28000E+00
N(5) N(3)    .12800E+03
K       .12000E+02
Na      .47000E+02  Charge
Ca      .40300E+03
Mg      .13200E+04
S(6)    .64500E+04
Cl      .12000E+02
Al      .33000E+01
As(5) As(3)   .95000E-02
Ba      .10000E+00
Cd      .10000E+00
Cu(2) Cu(1) .43100E+01
Fe(2) Fe(3)     .18500E+02
Pb      .10000E-01
Mn(2) Mn(3)     .56700E+01
Ni      .72000E+00
Si      .340000E+00 as H4SiO4
Ag      .50000E-02
Zn      .31100E+01
pH      4.8
pe      3.5599
Temp    10.0
PRINT
        -reset  false
END
TITLE WR-5
SOLUTION 5 WR5  Clastic Low sulfide
Units mg/L
C       .25000E+02 gfw 50.04460
F       .14000E+00
N(5) N(3)    .54930E+02
K       .10000E+01
Na      .60000E+01   Charge
Ca      .49000E+02
Mg      .11000E+02
S(6)    .92000E+02
```

```
Cl        .10000E+01
Al        .10000E+00
As(5) As(3)    .95000E-02
Ba        .10000E+00
Cd        .10000E-02
Cu(2) Cu(1) .10000E-01
Fe(2) Fe(3)       .11000E+00
Pb        .10000E-01
Mn(2) Mn(3)       .40000E-01
Ni        .10000E-01
Si        .41000E+01 as H4SiO4
Ag        .50000E-02
Zn        .20000E-01
pH        8
pe        3.5599
Temp      10.0
PRINT
          -reset  false
END
TITLE  Neutralized ARD
SOLUTION 6 Neutralized ARD
Units    mg/l
K         .10000E+01
Na        .80000E+01   Charge
Zn        .16000E+01
C         .55000E+03   gfw 50.04460
Ag        .10000E-01
Ca        .68000E+03
Mg        .30800E+03
S(6)      .25600E+04
Cl        .10000E+01
Al        .30000E-01
As(5) As(3)    .95000E-02
Ba        .10000E+00
Cd        .300000-02
Cu(2) Cu(1) .57000E+00
Fe(2) Fe(3)       .20000E-01
Pb        .10000E-02
Mn(2) Mn(3)       .31500E+01
Ni        .70000E-01
Si        .54750E+02 as H4SiO4
Temp      10.0
pH        7.1
pe        4.8136
PRINT
          -reset  false
END
TITLE   LF120 SEEP
SOLUTION 7  LF120 Seep
Units mg/L
F         .33000E+00
N(5) N(3)     .22200E+00
K         .30000E+01
Na        .13000E+02  Charge
Zn        .20000E-01
Ca        .37400E+03
Mg        .86000E+02
S(6)      .97800E+03
Cl        .90000E+01
Al        .10000E+00
As(5) As(3) .95000E-02
Ba        .10000E+00
Cd        .10000E-02
Cu(2) Cu(1) .10000E-01
Fe(2) Fe(3)       .20500E+02
Pb        .10000E-01
Mn(2) Mn(3)       .27000E+00
Ni        .10000E-01
Si        .47910E+02 as H4SiO4
Ag        .50000E-02
C         .33400E+03 gfw 50.04460
```

```
Temp     10.0
pH       7.1
pe       -0.2068
PRINT
        -reset false
END
TITLE  ARD water without neutralizing
SOLUTION 8  ARD Water without neutralizing
Units   mg/l
K        .10000E+01
Na       .80000E+01 Charge
Zn       69.56
C        2.0   gfw 50.04460
Ag       0.1
Ca       362.0
Mg       266
S(6)     22000
Cl       .10000E+01
Al       256
As(5) As(3)   114
Ba       .10000E+00
Cd       0.32
Cu(2) Cu(1) 1300
Fe(2) Fe(3)     8500
Pb    0.13
Mn(2) Mn(3)     13
Ni    0.48
Temp     10.0
pH       2.3
pe       4.8136
PRINT
        -reset  false
END
TITLE Mix solution 1,2,3,4,5
MIX      1
1 0.1305
2 0.2649
3 0.1214
4 0.2432
5 0.2400
SAVE Solution 9
PRINT
        -reset  false
END
#Filling
TITLE Mix solution 9,8,7 - Wall Rock,ard and lfc120
MIX      1
9 0.521739
8 0.000148
7 0.478113
SAVE Solution 12
PRINT
        -reset  false
END
TITLE   Equilibrate mixed solution with  pCO2 -2.5
EQUILIBRIUM_PHASES 1
        CO2(g)  -2.5     0.0
USE Solution 12
SAVE Solution 18
PRINT
        -reset  false
END
#Full
TITLE Mix solution 6,7 - neutralized Ard,lfc120
MIX      1
6 0.686
7 0.314
SAVE Solution 30
PRINT
        -reset  false
END
```

```
TITLE   Equilibrate mixed solution with  pCO2 -2.5
EQUILIBRIUM_PHASES 1
       CO2(g)  -2.5     0.0
USE Solution 30
SAVE Solution 0
PRINT
        -reset  false
END
SURFACE 4
   Hfo_s        0.00025   600     5.4
   Hfo_w        0.0100
        -diffuse_layer
END
#Filling Solution ,-2.5
TITLE   Equil. mixed solution fix redox and pCO2=-2.5
PHASES
        Fix_e-
        e-=e-
        log_k   0.0
EQUILIBRIUM_PHASES 0
        CO2(g)  -2.5    0.00
       Use Solution 0
       Save Solution 0
KNOBS
        -DIAGONAL_SCALE True
        -step_size      75
        -iterations     500
        -tolerance      1e-14
        -pe_step_size   5
PRINT
        -reset  false
END
#10% Pyrite,100 mV,-2.5
TITLE   Equil. mixed solution with CaCo3,fes2, fix redox and pCO2=-2.5 C-M
PHASES
        Fix_e-
        e-=e-
        log_k   0.0
EQUILIBRIUM_PHASES 1
        Calcite 0.0     3.844
        Pyrite  0.0     0.05
        CO2(g)  -2.5    0.00
        Fix_e-          -1.695     O2  100.0
        Alunite         0.0     0.0
        Gypsum          0.0     0.0
        Barite          0.0     0.0
        Siderite        0.0     0.0
        Boehmite        0.0     0.0
        Brochantite     0.0     0.0
        Jarosite-K      0.0     0.0
        Al4(OH)10SO4    0.0     0.0
        Antlerite       0.0     0.0
        Al(OH)3(a)      0.0     0.0
        Malachite       0.0     0.0
        Ferrihydrite    0.0     0.0
        Azurite         0.0     0.0
        Anglesite       0.0     0.0
        Otavite         0.0     0.0
        Smithsonite     0.0     0.0
        ZnCO3:H2O       0.0     0.0
        Ca3(AsO4)2:6H2O 0.0     0.0
        USE Solution 18
        USE Surface 4
        Save Solution 1
        Save Surface 1
KNOBS
        -DIAGONAL_SCALE True
        -step_size      75
        -iterations     500
        -tolerance      1e-14
        -pe_step_size   5
```

```
PRINT
        -reset  false
END
#Full Solution
TITLE   Transport pore volumes    C-Q
PHASES
        Fix_e-
        e-=e-
        log_k   0.0
EQUILIBRIUM_PHASES 1
        Calcite 0.0     3.748
        Pyrite  0.0     0.000
        CO2(g)  -2.5    0.00
        Fix_e-          0.0   O2  100.0
        Gypsum          0.0     9.51e-2
        Alunite         0.0     0.0
        Barite          0.0     7.03E-7
        Siderite        0.0     0.0
        Boehmite        0.0     2.08E-5
        Brochantite     0.0     0.0
        Jarosite-K      0.0     0.0
        Al4(OH)10SO4    0.0     0.0
        Antlerite       0.0     0.0
        Al(OH)3(a)      0.0     0.0
        Malachite       0.0     0.0
        Ferrihydrite    0.0     0.0
        Azurite         0.0     0.0
        Anglesite       0.0     0.0
        Otavite         0.0     0.0
        Smithsonite     0.0     0.0
        ZnCO3:H2O       0.0     0.0
        Ca3(AsO4)2:6H2O 0.0     0.0
TRANSPORT
       -cells 1
       -shifts 10
KNOBS
        -DIAGONAL_SCALE True
        -step_size      10
        -iterations     500
        -tolerance      1e-14
        -pe_step_size   .5
PRINT
        -reset false
        -totals true
        -equilibrium_phases     true
        -surface        true
END
```

C2 – Model Output

```
------------------
Reading data base.
------------------

        SOLUTION_MASTER_SPECIES
        SOLUTION_SPECIES
        SOLUTION_SPECIES
        PHASES
        SURFACE_MASTER_SPECIES
        SURFACE_SPECIES
        END
-------------------------------------
Reading input data for simulation 1.
-------------------------------------

        SELECTED_OUTPUT
                file short.out
                totals F Cl N(5) N(3) C(4) S(6) Na K Cu(1) Ag Ca Mg Ba Cd Cu(2) Pb Ni Zn Fe(2) Mn(2)
Al Fe(3) Mn(3) As(3) As(5)
                equilibrium_phases Calcite Pyrite CO2(g) Alunite Gypsum Barite Siderite Boehmite
Brochantite Jarosite-K Al4(OH)10SO4 Antlerite Al(OH)3(a) Malachite Ferrihydrite Azurite Anglesite
Otavite Smithsonite ZnCO3:H2O Ca3(AsO4)2:6H2O
                molalities Hfo_sOCu+ Hfo_sOZn+ Hfo_sOHAsO4-3 Hfo_sAsO4-2 Hfo_sHAsO4- Hfo_sH2AsO4
Hfo_sH2AsO3 Hfo_wOCu+ Hfo_wOZn+ Hfo_wOHAsO4-3 Hfo_wAsO4-2 Hfo_wHAsO4- Hfo_wH2AsO4 Hfo_wH2AsO3
                END
------------------
End of simulation.
------------------

-------------------------------------
Reading input data for simulation 2.
-------------------------------------

        TITLE WR-1
        SOLUTION 1      WR-1  Massive Unaltered Limestone, no sulfide
        Units   mg/l
        C               .18000E+02 gfw 50.04460
        F               .22000E+00
        N(5) N(3)        .67340E+02
        K               .10000E+01
        Na              .20000E+01   Charge
        Ca              .19100E+03
        Mg              .94000E+02
        S(6)            .70400E+03
        Cl              .10000E+01
        Al              .10000E+00
        As(5) As(3)           .95000E-02
        Ba              .10000E+00
        Cd              .10000E-02
        Cu(2) Cu(1)                .10000E-01
        Fe(2) Fe(3)    .30000E-01
        Pb              .10000E-01
        Mn(2) Mn(3)    .10000E-01
        Ni              .10000E-01
        Si              .20500E+01 as H4SiO4
        Ag              .50000E-02
        Zn              .10000E-01
        Temp            10.00
        pH              8.4
        pe              3.5599
        PRINT
                reset false
        END
-----
TITLE
-----

 WR-1

-------------------------------------------
Beginning of initial solution calculations.
```

```
-------------------------------------------

Initial solution 1.    WR-1  Massive Unaltered Limestone, no sulfide

------------------
End of simulation.
------------------

-------------------------------------
Reading input data for simulation 3.
-------------------------------------

       TITLE WR-2
       SOLUTION 2 WR-2  Massive Magnetite with calcite veining , low sulfides
       Units mg/L
       C       .21000E+02 gfw 50.04460
       F       .12000E+00
       N(5) N(3)   .25300E+02
       K       .10000E+01
       Na      .10000E+01  Charge
       Ca      .76000E+02
       Mg      .10000E+02
       S(6)    .15700E+03
       Cl      .10000E+01
       Al      .30000E+00
       As(5) As(3)   .95000E-02
       Ba      .10000E+00
       Cd      .10000E-02
       Cu(2) Cu(1) .10000E-01
       Fe(2) Fe(3)     .30000E-01
       Pb      .10000E-01
       Mn(3) Mn(2) .10000E-01
       Ni      .10000E-01
       Si      .34220E+01 as H4SiO4
       Ag      .50000E-02
       Zn      .20000E-01
       pH      8.1
       pe      3.5599
       Temp    10.0
       PRINT
              reset  false
       END
-----
TITLE
-----

 WR-2

-------------------------------------------
Beginning of initial solution calculations.
-------------------------------------------

Initial solution 2.    WR-2  Massive Magnetite with calcite veining , low sulfides

------------------
End of simulation.
------------------

-------------------------------------
Reading input data for simulation 4.
-------------------------------------

       TITLE WR-3
       SOLUTION 3      WR-3  Massive sulfide and magnetite
       Units mg/L
       C       .31000E+02 gfw 50.04460
       F       .12000E+00
       N(5) N(3)    .10145E+03
       K       .11000E+02
       Na      .11000E+02   Charge
       Ca      .19000E+03
```

```
        Mg       .23500E+03
        S(6)     .14300E+04
        Cl       .20000E+01
        Al       .10000E+00
        As(5) As(3)    .95000E-02
        Ba       .10000E+00
        Cd       .27000E-01
        Cu(2) Cu(1) .10000E-01
        Fe(2) Fe(3)      .18000E+00
        Pb       .10000E-01
        Mn(2) Mn(3)      .43600E+01
        Ni       .10000E-01
        Si       .30800E+01 as H4SiO4
        Ag       .50000E-02
        Zn       .12200E+02
        pH       6.8
        pe       3.5599
        Temp     10.0
        PRINT
                reset  false
        END
-----
TITLE
-----

 WR-3

-------------------------------------------
Beginning of initial solution calculations.
-------------------------------------------

Initial solution 3.    WR-3  Massive sulfide and magnetite

------------------
End of simulation.
------------------

-----------------------------------
Reading input data for simulation 5.
-----------------------------------

        TITLE WR-4
        SOLUTION 4 WR4  Clastic with high S content
        Units mg/L
        C        .20000E+01 gfw 50.04460
        F        .28000E+00
        N(5) N(3)     .12800E+03
        K        .12000E+02
        Na       .47000E+02  Charge
        Ca       .40300E+03
        Mg       .13200E+04
        S(6)     .64500E+04
        Cl       .12000E+02
        Al       .33000E+01
        As(5) As(3)    .95000E-02
        Ba       .10000E+00
        Cd       .10000E+00
        Cu(2) Cu(1) .43100E+01
        Fe(2) Fe(3)      .18500E+02
        Pb       .10000E-01
        Mn(2) Mn(3)      .56700E+01
        Ni       .72000E+00
        Si       .340000E+00 as H4SiO4
        Ag       .50000E-02
        Zn       .31100E+01
        pH       4.8
        pe       3.5599
        Temp     10.0
        PRINT
                reset  false
        END
```

```
-----
TITLE
-----

 WR-4

-------------------------------------------
Beginning of initial solution calculations.
-------------------------------------------

Initial solution 4.    WR4  Clastic with high S content

------------------
End of simulation.
------------------

-------------------------------------
Reading input data for simulation 6.
-------------------------------------

        TITLE WR-5
        SOLUTION 5 WR5  Clastic Low sulfide
        Units mg/L
        C        .25000E+02 gfw 50.04460
        F        .14000E+00
        N(5) N(3)     .54930E+02
        K        .10000E+01
        Na       .60000E+01   Charge
        Ca       .49000E+02
        Mg       .11000E+02
        S(6)     .92000E+02
        Cl       .10000E+01
        Al       .10000E+00
        As(5) As(3)    .95000E-02
        Ba       .10000E+00
        Cd       .10000E-02
        Cu(2) Cu(1) .10000E-01
        Fe(2) Fe(3)      .11000E+00
        Pb       .10000E-01
        Mn(2) Mn(3)      .40000E-01
        Ni       .10000E-01
        Si       .41000E+01 as H4SiO4
        Ag       .50000E-02
        Zn       .20000E-01
        pH       8
        pe       3.5599
        Temp     10.0
        PRINT
                reset  false
        END
-----
TITLE
-----

 WR-5

-------------------------------------------
Beginning of initial solution calculations.
-------------------------------------------

Initial solution 5.    WR5  Clastic Low sulfide

------------------
End of simulation.
------------------

-------------------------------------
Reading input data for simulation 7.
-------------------------------------

        TITLE  Neutralized ARD
```

```
        SOLUTION 6 Neutralized ARD
        Units   mg/l
        K       .10000E+01
        Na      .80000E+01   Charge
        Zn      .16000E+01
        C       .55000E+03   gfw 50.04460
        Ag      .10000E-01
        Ca      .68000E+03
        Mg      .30800E+03
        S(6)    .25600E+04
        Cl      .10000E+01
        Al      .30000E-01
        As(5) As(3)   .95000E-02
        Ba      .10000E+00
        Cd      .300000-02
        Cu(2) Cu(1) .57000E+00
        Fe(2) Fe(3)     .20000E-01
        Pb      .10000E-02
        Mn(2) Mn(3)     .31500E+01
        Ni      .70000E-01
        Si      .54750E+02 as H4SiO4
        Temp    10.0
        pH      7.1
        pe      4.8136
        PRINT
                reset  false
        END
-----
TITLE
-----

  Neutralized ARD

-------------------------------------------
Beginning of initial solution calculations.
-------------------------------------------

Initial solution 6.   Neutralized ARD

------------------
End of simulation.
------------------

-------------------------------------
Reading input data for simulation 8.
-------------------------------------

        TITLE   LF120 SEEP
        SOLUTION 7  LF120 Seep
        Units mg/L
        F       .33000E+00
        N(5) N(3)    .22200E+00
        K       .30000E+01
        Na      .13000E+02  Charge
        Zn      .20000E-01
        Ca      .37400E+03
        Mg      .86000E+02
        S(6)    .97800E+03
        Cl      .90000E+01
        Al      .10000E+00
        As(5) As(3) .95000E-02
        Ba      .10000E+00
        Cd      .10000E-02
        Cu(2) Cu(1) .10000E-01
        Fe(2) Fe(3)     .20500E+02
        Pb      .10000E-01
        Mn(2) Mn(3)      .27000E+00
        Ni      .10000E-01
        Si      .47910E+02 as H4SiO4
        Ag      .50000E-02
        C       .33400E+03 gfw 50.04460
```

```
        Temp     10.0
        pH       7.1
        pe       -0.2068
        PRINT
                 reset false
        END
-----
TITLE
-----

  LF120 SEEP

-----------------------------------------
Beginning of initial solution calculations.
-----------------------------------------

Initial solution 7.    LF120 Seep

------------------
End of simulation.
------------------

-----------------------------------
Reading input data for simulation 9.
-----------------------------------

        TITLE  ARD water without neutralizing
        SOLUTION 8  ARD Water without neutralizing
        Units   mg/l
        K        .10000E+01
        Na       .80000E+01 Charge
        Zn       69.56
        C        2.0   gfw 50.04460
        Ag       0.1
        Ca       362.0
        Mg       266
        S(6)     22000
        Cl       .10000E+01
        Al       256
        As(5) As(3)   114
        Ba       .10000E+00
        Cd       0.32
        Cu(2) Cu(1) 1300
        Fe(2) Fe(3)     8500
        Pb    0.13
        Mn(2) Mn(3)     13
        Ni    0.48
        Temp     10.0
        pH       2.3
        pe       4.8136
        PRINT
                 reset  false
        END
-----
TITLE
-----

  ARD water without neutralizing

-----------------------------------------
Beginning of initial solution calculations.
-----------------------------------------

Initial solution 8.    ARD Water without neutralizing

------------------
End of simulation.
------------------

-----------------------------------
Reading input data for simulation 10.
```

```
-------------------------------------

       TITLE Mix solution 1,2,3,4,5
       MIX     1
       1 0.1305
       2 0.2649
       3 0.1214
       4 0.2432
       5 0.2400
       SAVE Solution 9
       PRINT
              reset  false
       END
-----
TITLE
-----

 Mix solution 1,2,3,4,5

-----------------------------------
Beginning of reaction calculations.
-----------------------------------

Reaction step 1.

------------------
End of simulation.
------------------

-------------------------------------
Reading input data for simulation 11.
-------------------------------------

       TITLE Mix solution 9,8,7 - Wall Rock,ard and lfc120
       MIX     1
       9 0.521739
       8 0.000148
       7 0.478113
       SAVE Solution 12
       PRINT
              reset  false
       END
-----
TITLE
-----

 Mix solution 9,8,7 - Wall Rock,ard and lfc120

-----------------------------------
Beginning of reaction calculations.
-----------------------------------

Reaction step 1.

------------------
End of simulation.
------------------

-------------------------------------
Reading input data for simulation 12.
-------------------------------------

       TITLE   Equilibrate mixed solution with  pCO2 -2.5
       EQUILIBRIUM_PHASES 1
              CO2(g)  -2.5     0.0
       USE Solution 12
       SAVE Solution 18
       PRINT
              reset  false
       END
-----
```

```
TITLE
-----

   Equilibrate mixed solution with  pCO2 -2.5

-----------------------------------
Beginning of reaction calculations.
-----------------------------------

Reaction step 1.

------------------
End of simulation.
------------------

-------------------------------------
Reading input data for simulation 13.
-------------------------------------

        TITLE Mix solution 6,7 - neutralized Ard,lfc120
        MIX     1
        6 0.686
        7 0.314
        SAVE Solution 30
        PRINT
                reset  false
        END
-----
TITLE
-----

 Mix solution 6,7 - neutralized Ard,lfc120

-----------------------------------
Beginning of reaction calculations.
-----------------------------------

Reaction step 1.

------------------
End of simulation.
------------------

-------------------------------------
Reading input data for simulation 14.
-------------------------------------

        TITLE   Equilibrate mixed solution with  pCO2 -2.5
        EQUILIBRIUM_PHASES 1
                CO2(g)  -2.5     0.0
        USE Solution 30
        SAVE Solution 0
        PRINT
                reset  false
        END
-----
TITLE
-----

   Equilibrate mixed solution with  pCO2 -2.5

-----------------------------------
Beginning of reaction calculations.
-----------------------------------

Reaction step 1.

------------------
End of simulation.
------------------
```

```
------------------------------------
Reading input data for simulation 15.
------------------------------------

        SURFACE 4
           Hfo_s        0.00025   600     5.4
           Hfo_w        0.0100
                diffuse_layer
        END
------------------
End of simulation.
------------------

------------------------------------
Reading input data for simulation 16.
------------------------------------

        TITLE   Equil. mixed solution fix redox and pCO2=-2.5
        PHASES
                Fix_e-
                e-=e-
                log_k   0.0
        EQUILIBRIUM_PHASES 0
                CO2(g)  -2.5    0.00
               Use Solution 0
               Save Solution 0
        KNOBS
                diagonal_scale True
                step_size       75
                iterations      500
                tolerance       1e-14
                pe_step_size    5
        PRINT
                reset  false
        END
-----
TITLE
-----

   Equil. mixed solution fix redox and pCO2=-2.5

-----------------------------------
Beginning of reaction calculations.
-----------------------------------

Reaction step 1.

------------------
End of simulation.
------------------

------------------------------------
Reading input data for simulation 17.
------------------------------------

        TITLE   Equil. mixed solution with CaCo3,fes2, fix redox and pCO2=-2.5 C-M
        PHASES
                Fix_e-
                e-=e-
                log_k   0.0
        EQUILIBRIUM_PHASES 1
                Calcite 0.0     3.844
                Pyrite  0.0     0.05
                CO2(g)  -2.5    0.00
                Fix_e-          -1.695      O2  100.0
                Alunite         0.0     0.0
                Gypsum          0.0     0.0
                Barite          0.0     0.0
                Siderite        0.0     0.0
                Boehmite        0.0     0.0
                Brochantite     0.0     0.0
```

```
            Jarosite-K       0.0      0.0
            Al4(OH)10SO4     0.0      0.0
            Antlerite        0.0      0.0
            Al(OH)3(a)       0.0      0.0
            Malachite        0.0      0.0
            Ferrihydrite     0.0      0.0
            Azurite          0.0      0.0
            Anglesite        0.0      0.0
            Otavite          0.0      0.0
            Smithsonite      0.0      0.0
            ZnCO3:H2O        0.0      0.0
            Ca3(AsO4)2:6H2O  0.0      0.0
            USE Solution 18
            USE Surface 4
            Save Solution 1
            Save Surface 1
      KNOBS
            diagonal_scale True
            step_size      75
            iterations     500
            tolerance      1e-14
            pe_step_size   5
      PRINT
            reset  false
      END
-----
TITLE
-----

   Equil. mixed solution with CaCo3,fes2, fix redox and pCO2=-2.5 C-M

-----------------------------------
Beginning of reaction calculations.
-----------------------------------

Reaction step 1.

Surface_model iteration: 1,   0 iterations
Surface_model iteration: 2,   5 iterations
Surface_model iteration: 3,   3 iterations
Surface_model iteration: 4,   1 iterations
------------------
End of simulation.
------------------

-------------------------------------
Reading input data for simulation 18.
-------------------------------------

      TITLE   Transport pore volumes    C-Q
      PHASES
            Fix_e-
            e-=e-
            log_k   0.0
      EQUILIBRIUM_PHASES 1
            Calcite 0.0      3.748
            Pyrite  0.0      0.000
            CO2(g)  -2.5     0.00
            Fix_e-           0.0    O2  100.0
            Gypsum           0.0      9.51e-2
            Alunite          0.0      0.0
            Barite           0.0      7.03E-7
            Siderite         0.0      0.0
            Boehmite         0.0      2.08E-5
            Brochantite      0.0      0.0
            Jarosite-K       0.0      0.0
            Al4(OH)10SO4     0.0      0.0
            Antlerite        0.0      0.0
            Al(OH)3(a)       0.0      0.0
            Malachite        0.0      0.0
            Ferrihydrite     0.0      0.0
```

```
            Azurite          0.0      0.0
            Anglesite        0.0      0.0
            Otavite          0.0      0.0
            Smithsonite      0.0      0.0
            ZnCO3:H2O        0.0      0.0
            Ca3(AsO4)2:6H2O  0.0      0.0
      TRANSPORT
            cells 1
            shifts 10
      KNOBS
            diagonal_scale True
            step_size      10
            iterations     500
            tolerance      1e-14
            pe_step_size   .5
      PRINT
            reset false
            totals true
            equilibrium_phases     true
            surface        true
      END
-----
TITLE
-----

   Transport pore volumes    C-Q

------------------------------------
Beginning of transport calculations.
------------------------------------

Surface_model iteration: 1,   0 iterations
Surface_model iteration: 2,   2 iterations
Surface_model iteration: 3,   1 iterations
-------------------------------Phase assemblage--------------------------------

                                                    Moles in assemblage
      Phase                SI log IAP  log KT    Initial      Final      Delta

      Al(OH)3(a)        -1.76    9.67   11.43  0.000e+00              0.000e+00
      Al4(OH)10SO4      -1.15   21.55   22.70  0.000e+00              0.000e+00
      Alunite           -0.79   -2.28   -1.50  0.000e+00              0.000e+00
      Anglesite         -8.04  -15.91   -7.87  0.000e+00              0.000e+00
      Antlerite        -11.67   -3.38    8.29  0.000e+00              0.000e+00
      Azurite          -11.61  -27.61  -16.00  0.000e+00              0.000e+00
      Barite             0.00  -10.22  -10.22  7.030e-07  1.410e-06  7.072e-07
      Boehmite           0.00    9.67    9.67  2.080e-05  2.222e-05  1.423e-06
      Brochantite      -14.13    1.21   15.34  0.000e+00              0.000e+00
      Ca3(AsO4)2:6H2O  -19.98    2.32   22.30  0.000e+00              0.000e+00
      Calcite            0.00   -8.41   -8.41  3.748e+00  3.751e+00  3.199e-03
      CO2(g)            -2.50  -20.68  -18.18  0.000e+00  4.091e-03  4.091e-03
      Ferrihydrite      -0.54   17.77   18.31  0.000e+00              0.000e+00
      Fix_e-             0.00    0.00    0.00
            O2                 is reactant     1.000e+02  1.000e+02  7.474e-06
      Gypsum             0.00   -4.86   -4.86  9.510e-02  9.893e-02  3.832e-03
      Jarosite-K        -4.65   22.02   26.68  0.000e+00              0.000e+00
      Malachite         -6.94  -11.51   -4.57  0.000e+00              0.000e+00
      Otavite           -0.20  -13.92  -13.72  0.000e+00              0.000e+00
      Pyrite           -37.11 -128.02  -90.91  0.000e+00              0.000e+00
      Siderite           0.00  -10.34  -10.34  0.000e+00  3.203e-05  3.203e-05
      Smithsonite       -3.55  -13.38   -9.83  0.000e+00              0.000e+00
      ZnCO3:H2O         -3.12  -13.38  -10.26  0.000e+00              0.000e+00

------------------------------Surface composition------------------------------

Hfo
      -3.147e-11  Net surface charge, eq
      -9.372e-10  sigma, C/m**2
       1.853e-02  psi, V
      -7.593e-01  -F*psi/RT
       4.680e-01  exp(-F*psi/RT)
```

6.000e+02 specific area, m**2/g
5.400e+00 mass, g

Kg water in diffuse layer: 3.240000e-02

Total moles in diffuse layer (excluding water)

Element	Moles
Ag	2.3660e-09
Al	1.6563e-08
As	5.5888e-13
Ba	6.5215e-10
C	8.4192e-05
Ca	2.2224e-04
Cd	1.0418e-09
Cl	3.7014e-06
Cu	9.1753e-10
F	2.0234e-07
Fe	2.3591e-06
H	1.6759e-04
K	1.2979e-06
Mg	2.8646e-04
Mn	1.1758e-06
N	2.4779e-06
Na	7.8392e-05
Ni	3.4590e-09
O	3.1136e-03
Pb	2.4326e-14
S	6.9775e-04
Si	1.7491e-05
Zn	3.0786e-09

Hfo_s

2.500e-04 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_sOHCa+2	2.254e-04	-3.647	2.254e-04	-3.647
Hfo_sOZn+	1.383e-05	-4.859	1.383e-05	-4.859
Hfo_sOH	4.350e-06	-5.362	4.350e-06	-5.362
Hfo_sOCu+	2.038e-06	-5.691	2.038e-06	-5.691
Hfo_sOH2+	1.457e-06	-5.836	1.457e-06	-5.836
Hfo_sOCd+	1.171e-06	-5.931	1.171e-06	-5.931
Hfo_sOHSO4-2	6.703e-07	-6.174	6.703e-07	-6.174
Hfo_sONi+	5.809e-07	-6.236	5.810e-07	-6.236
Hfo_sO-	2.974e-07	-6.527	2.974e-07	-6.527
Hfo_sSO4-	1.126e-07	-6.948	1.126e-07	-6.948
Hfo_sOPb+	6.350e-08	-7.197	6.350e-08	-7.197
Hfo_sOHBa+2	3.025e-09	-8.519	3.026e-09	-8.519
Hfo_sOHAsO4-3	3.398e-10	-9.469	3.399e-10	-9.469
Hfo_sH2AsO3	3.437e-12	-11.464	3.437e-12	-11.464
Hfo_sAsO4-2	1.647e-12	-11.783	1.647e-12	-11.783
Hfo_sHAsO4-	1.386e-12	-11.858	1.386e-12	-11.858
Hfo_sH2AsO4	1.140e-14	-13.943	1.140e-14	-13.943

Hfo_w

1.000e-02 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_wOH	6.114e-03	-2.214	6.114e-03	-2.214
Hfo_wOH2+	2.048e-03	-2.689	2.048e-03	-2.689
Hfo_wOHSO4-2	9.422e-04	-3.026	9.422e-04	-3.026
Hfo_wO-	4.181e-04	-3.379	4.181e-04	-3.379
Hfo_wOCa+	2.791e-04	-3.554	2.791e-04	-3.554
Hfo_wSO4-	1.583e-04	-3.801	1.583e-04	-3.801
Hfo_wOZn+	2.131e-05	-4.671	2.131e-05	-4.671
Hfo_wOCu+	1.611e-05	-4.793	1.611e-05	-4.793
Hfo_wONi+	1.828e-06	-5.738	1.828e-06	-5.738
Hfo_wOCd+	7.698e-07	-6.114	7.698e-07	-6.114
Hfo_wOHAsO4-3	4.777e-07	-6.321	4.777e-07	-6.321

Hfo_wH2AsO3	4.831e-09	-8.316	4.831e-09	-8.316
Hfo_wOPb+	3.472e-09	-8.459	3.472e-09	-8.459
Hfo_wAsO4-2	2.315e-09	-8.636	2.315e-09	-8.636
Hfo_wHAsO4-	1.948e-09	-8.710	1.948e-09	-8.710
Hfo_wOBa+	5.415e-11	-10.266	5.415e-11	-10.266
Hfo_wH2AsO4	1.602e-11	-10.795	1.602e-11	-10.795

----------Solution composition----------

Elements	Molality	Moles
Ag	7.748e-08	7.748e-08
Al	5.089e-07	5.089e-07
As	1.408e-11	1.408e-11
Ba	2.352e-08	2.351e-08
C	2.350e-03	2.350e-03
Ca	7.598e-03	7.598e-03
Cd	3.423e-08	3.423e-08
Cl	1.018e-04	1.018e-04
Cu	3.078e-08	3.078e-08
F	5.714e-06	5.714e-06
Fe	8.150e-05	8.150e-05
K	4.345e-05	4.345e-05
Mg	9.830e-03	9.829e-03
Mn	4.046e-05	4.046e-05
N	8.226e-05	8.226e-05
Na	2.626e-03	2.626e-03
Ni	1.091e-07	1.090e-07
Pb	7.582e-13	7.581e-13
S	1.775e-02	1.775e-02
Si	5.397e-04	5.397e-04
Zn	1.021e-07	1.021e-07

----------Description of solution----------

```
                        pH  =   7.435      Charge balance
                        pe  =   0.000      Adjusted to redox equilibrium
             Activity of water  =   0.999
                Ionic strength  =   5.110e-02
            Mass of water (kg)  =   9.999e-01
       Total alkalinity (eq/kg)  =   2.244e-03
            Total CO2 (mol/kg)  =   2.350e-03
          Temperature (deg C)  =  10.000
        Electrical balance (eq)  =   7.286e-10
                   Iterations  =   1
                      Total H  = 1.110102e+02
                      Total O  = 5.558285e+01

Surface_model iteration: 1,   0 iterations
Surface_model iteration: 2,   1 iterations
Surface_model iteration: 3,   0 iterations
```

----------Phase assemblage----------

Phase	SI	log IAP	log KT	Moles in assemblage Initial	Final	Delta
Al(OH)3(a)	-1.76	9.67	11.43	0.000e+00		0.000e+00
Al4(OH)10SO4	-1.15	21.55	22.70	0.000e+00		0.000e+00
Alunite	-0.80	-2.30	-1.50	0.000e+00		0.000e+00
Anglesite	-7.92	-15.79	-7.87	0.000e+00		0.000e+00
Antlerite	-11.28	-2.99	8.29	0.000e+00		0.000e+00
Azurite	-11.22	-27.21	-16.00	0.000e+00		0.000e+00
Barite	0.00	-10.22	-10.22	1.410e-06	2.117e-06	7.073e-07
Boehmite	0.00	9.67	9.67	2.222e-05	2.365e-05	1.423e-06
Brochantite	-13.61	1.73	15.34	0.000e+00		0.000e+00
Ca3(AsO4)2:6H2O	-19.78	2.52	22.30	0.000e+00		0.000e+00
Calcite	0.00	-8.41	-8.41	3.751e+00	3.754e+00	3.196e-03
CO2(g)	-2.50	-20.68	-18.18	4.091e-03	8.182e-03	4.091e-03
Ferrihydrite	-0.54	17.77	18.31	0.000e+00		0.000e+00
Fix_e-	0.00	0.00	0.00			
O2		is reactant		1.000e+02	1.000e+02	7.475e-06

Gypsum	0.00	-4.86	-4.86	9.893e-02	1.028e-01	3.833e-03
Jarosite-K	-4.67	22.00	26.68	0.000e+00		0.000e+00
Malachite	-6.68	-11.25	-4.57	0.000e+00		0.000e+00
Otavite	0.00	-13.72	-13.72	0.000e+00	7.258e-07	7.258e-07
Pyrite	-37.10	-128.01	-90.91	0.000e+00		0.000e+00
Siderite	0.00	-10.34	-10.34	3.203e-05	6.619e-05	3.417e-05
Smithsonite	-3.38	-13.21	-9.83	0.000e+00		0.000e+00
ZnCO3:H2O	-2.95	-13.21	-10.26	0.000e+00		0.000e+00

----------Surface composition----------

Hfo

```
 1.931e-09  Net surface charge, eq
 5.751e-08  sigma, C/m**2
 1.857e-02  psi, V
-7.613e-01  -F*psi/RT
 4.671e-01  exp(-F*psi/RT)
 6.000e+02  specific area, m**2/g
 5.400e+00  mass, g
```

Kg water in diffuse layer: 3.240000e-02

Total moles in diffuse layer (excluding water)

Element	Moles
Ag	2.3938e-09
Al	1.6563e-08
As	7.0318e-13
Ba	6.5253e-10
C	8.4173e-05
Ca	2.2233e-04
Cd	1.6453e-09
Cl	3.6139e-06
Cu	1.2391e-09
F	1.9385e-07
Fe	2.3601e-06
H	1.5973e-04
K	1.2485e-06
Mg	2.8669e-04
Mn	1.1920e-06
N	2.1823e-07
Na	7.8189e-05
Ni	4.5536e-09
O	3.1131e-03
Pb	3.2021e-14
S	6.9733e-04
Si	1.7789e-05
Zn	4.6186e-09

Hfo_s

2.500e-04 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_sOHCa+2	2.180e-04	-3.662	2.180e-04	-3.662
Hfo_sOZn+	2.008e-05	-4.697	2.008e-05	-4.697
Hfo_sOH	4.217e-06	-5.375	4.217e-06	-5.375
Hfo_sOCu+	2.662e-06	-5.575	2.662e-06	-5.575
Hfo_sOCd+	1.790e-06	-5.747	1.790e-06	-5.747
Hfo_sOH2+	1.411e-06	-5.851	1.411e-06	-5.851
Hfo_sONi+	7.404e-07	-6.131	7.404e-07	-6.131
Hfo_sOHSO4-2	6.516e-07	-6.186	6.516e-07	-6.186
Hfo_sO-	2.887e-07	-6.540	2.887e-07	-6.539
Hfo_sSO4-	1.093e-07	-6.961	1.093e-07	-6.961
Hfo_sOPb+	8.092e-08	-7.092	8.093e-08	-7.092
Hfo_sOHBa+2	2.925e-09	-8.534	2.925e-09	-8.534
Hfo_sOHAsO4-3	4.163e-10	-9.381	4.163e-10	-9.381
Hfo_sH2AsO3	4.198e-12	-11.377	4.198e-12	-11.377
Hfo_sAsO4-2	2.014e-12	-11.696	2.014e-12	-11.696
Hfo_sHAsO4-	1.693e-12	-11.771	1.693e-12	-11.771
Hfo_sH2AsO4	1.390e-14	-13.857	1.390e-14	-13.857

Hfo_w

1.000e-02 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_wOH	6.103e-03	-2.214	6.103e-03	-2.214
Hfo_wOH2+	2.042e-03	-2.690	2.042e-03	-2.690
Hfo_wOHSO4-2	9.430e-04	-3.025	9.431e-04	-3.025
Hfo_wO-	4.179e-04	-3.379	4.179e-04	-3.379
Hfo_wOCa+	2.783e-04	-3.556	2.783e-04	-3.556
Hfo_wSO4-	1.582e-04	-3.801	1.582e-04	-3.801
Hfo_wOZn+	3.186e-05	-4.497	3.186e-05	-4.497
Hfo_wOCu+	2.167e-05	-4.664	2.167e-05	-4.664
Hfo_wONi+	2.399e-06	-5.620	2.399e-06	-5.620
Hfo_wOCd+	1.212e-06	-5.917	1.212e-06	-5.917
Hfo_wOHAsO4-3	6.025e-07	-6.220	6.025e-07	-6.220
Hfo_wH2AsO3	6.076e-09	-8.216	6.076e-09	-8.216
Hfo_wOPb+	4.556e-09	-8.341	4.557e-09	-8.341
Hfo_wAsO4-2	2.915e-09	-8.535	2.916e-09	-8.535
Hfo_wHAsO4-	2.450e-09	-8.611	2.450e-09	-8.611
Hfo_wOBa+	5.398e-11	-10.268	5.398e-11	-10.268
Hfo_wH2AsO4	2.012e-11	-10.696	2.012e-11	-10.696

----------Solution composition----------

Elements	Molality	Moles
Ag	7.842e-08	7.842e-08
Al	5.089e-07	5.089e-07
As	1.771e-11	1.771e-11
Ba	2.354e-08	2.354e-08
C	2.349e-03	2.349e-03
Ca	7.603e-03	7.603e-03
Cd	5.408e-08	5.407e-08
Cl	9.938e-05	9.938e-05
Cu	4.158e-08	4.158e-08
F	5.473e-06	5.473e-06
Fe	8.156e-05	8.156e-05
K	4.181e-05	4.180e-05
Mg	9.840e-03	9.840e-03
Mn	4.103e-05	4.103e-05
N	7.246e-06	7.246e-06
Na	2.620e-03	2.620e-03
Ni	1.436e-07	1.436e-07
Pb	9.980e-13	9.980e-13
S	1.773e-02	1.773e-02
Si	5.489e-04	5.489e-04
Zn	1.533e-07	1.532e-07

----------Description of solution----------

```
                        pH  =   7.435      Charge balance
                        pe  =   0.000      Adjusted to redox equilibrium
            Activity of water  =   0.999
               Ionic strength  =   5.105e-02
           Mass of water (kg)  =   9.999e-01
       Total alkalinity (eq/kg)  =   2.242e-03
            Total CO2 (mol/kg)  =   2.349e-03
          Temperature (deg C)  =  10.000
     Electrical balance (eq)  =  -3.146e-11
                 Iterations  =   0
                    Total H  = 1.110100e+02
                    Total O  = 5.558279e+01
```

Surface_model iteration: 1, 0 iterations
Surface_model iteration: 2, 1 iterations

----------Phase assemblage----------

Phase	SI	log IAP	log KT	Moles in assemblage Initial	Final	Delta

Al(OH)3(a)	-1.76	9.67	11.43	0.000e+00		0.000e+00
Al4(OH)10SO4	-1.15	21.55	22.70	0.000e+00		0.000e+00
Alunite	-0.80	-2.30	-1.50	0.000e+00		0.000e+00
Anglesite	-7.82	-15.70	-7.87	0.000e+00		0.000e+00
Antlerite	-10.97	-2.68	8.29	0.000e+00		0.000e+00
Azurite	-10.92	-26.91	-16.00	0.000e+00		0.000e+00
Barite	0.00	-10.22	-10.22	2.117e-06	2.825e-06	7.073e-07
Boehmite	0.00	9.67	9.67	2.365e-05	2.507e-05	1.423e-06
Brochantite	-13.21	2.13	15.34	0.000e+00		0.000e+00
Ca3(AsO4)2:6H2O	-19.62	2.68	22.30	0.000e+00		0.000e+00
Calcite	0.00	-8.41	-8.41	3.754e+00	3.758e+00	3.195e-03
CO2(g)	-2.50	-20.68	-18.18	8.182e-03	1.227e-02	4.091e-03
Ferrihydrite	-0.54	17.77	18.31	0.000e+00		0.000e+00
Fix_e-	0.00	0.00	0.00			
O2		is reactant		1.000e+02	1.000e+02	7.477e-06
Gypsum	0.00	-4.86	-4.86	1.028e-01	1.066e-01	3.832e-03
Jarosite-K	-4.67	22.00	26.68	0.000e+00		0.000e+00
Malachite	-6.47	-11.05	-4.57	0.000e+00		0.000e+00
Otavite	0.00	-13.72	-13.72	7.257e-07	2.569e-06	1.843e-06
Pyrite	-37.10	-128.01	-90.91	0.000e+00		0.000e+00
Siderite	0.00	-10.34	-10.34	6.619e-05	1.004e-04	3.417e-05
Smithsonite	-3.25	-13.08	-9.83	0.000e+00		0.000e+00
ZnCO3:H2O	-2.82	-13.08	-10.26	0.000e+00		0.000e+00

----------Surface composition----------

Hfo

5.010e-11	Net surface charge, eq
1.492e-09	sigma, C/m**2
1.861e-02	psi, V
-7.627e-01	-F*psi/RT
4.664e-01	exp(-F*psi/RT)
6.000e+02	specific area, m**2/g
5.400e+00	mass, g

Kg water in diffuse layer: 3.240000e-02

Total moles in diffuse layer (excluding water)

Element	Moles
Ag	2.3944e-09
Al	1.6563e-08
As	8.4710e-13
Ba	6.5240e-10
C	8.4190e-05
Ca	2.2230e-04
Cd	1.6452e-09
Cl	3.6116e-06
Cu	1.5628e-09
F	1.9360e-07
Fe	2.3598e-06
H	1.5952e-04
K	1.2469e-06
Mg	2.8666e-04
Mn	1.1923e-06
N	1.5214e-07
Na	7.8174e-05
Ni	5.6158e-09
O	3.1144e-03
Pb	4.0052e-14
S	6.9764e-04
Si	1.7799e-05
Zn	6.1886e-09

Hfo_s

2.500e-04 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_sOHCa+2	2.114e-04	-3.675	2.114e-04	-3.675

Hfo_sOZn+	2.613e-05	-4.583	2.613e-05	-4.583
Hfo_sOH	4.101e-06	-5.387	4.101e-06	-5.387
Hfo_sOCu+	3.261e-06	-5.487	3.261e-06	-5.487
Hfo_sOCd+	1.738e-06	-5.760	1.738e-06	-5.760
Hfo_sOH2+	1.370e-06	-5.863	1.370e-06	-5.863
Hfo_sONi+	8.868e-07	-6.052	8.868e-07	-6.052
Hfo_sOHSO4-2	6.355e-07	-6.197	6.355e-07	-6.197
Hfo_sO-	2.812e-07	-6.551	2.812e-07	-6.551
Hfo_sSO4-	1.065e-07	-6.973	1.065e-07	-6.973
Hfo_sOPb+	9.830e-08	-7.007	9.831e-08	-7.007
Hfo_sOHBa+2	2.837e-09	-8.547	2.837e-09	-8.547
Hfo_sOHAsO4-3	4.896e-10	-9.310	4.896e-10	-9.310
Hfo_sH2AsO3	4.916e-12	-11.308	4.917e-12	-11.308
Hfo_sAsO4-2	2.366e-12	-11.626	2.366e-12	-11.626
Hfo_sHAsO4-	1.985e-12	-11.702	1.985e-12	-11.702
Hfo_sH2AsO4	1.628e-14	-13.788	1.628e-14	-13.788

Hfo_w

1.000e-02 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_wOH	6.092e-03	-2.215	6.093e-03	-2.215
Hfo_wOH2+	2.035e-03	-2.691	2.036e-03	-2.691
Hfo_wOHSO4-2	9.441e-04	-3.025	9.441e-04	-3.025
Hfo_wO-	4.178e-04	-3.379	4.178e-04	-3.379
Hfo_wOCa+	2.774e-04	-3.557	2.774e-04	-3.557
Hfo_wSO4-	1.582e-04	-3.801	1.582e-04	-3.801
Hfo_wOZn+	4.256e-05	-4.371	4.256e-05	-4.371
Hfo_wOCu+	2.724e-05	-4.565	2.725e-05	-4.565
Hfo_wONi+	2.949e-06	-5.530	2.949e-06	-5.530
Hfo_wOCd+	1.208e-06	-5.918	1.208e-06	-5.918
Hfo_wOHAsO4-3	7.273e-07	-6.138	7.273e-07	-6.138
Hfo_wH2AsO3	7.304e-09	-8.136	7.304e-09	-8.136
Hfo_wOPb+	5.681e-09	-8.246	5.682e-09	-8.246
Hfo_wAsO4-2	3.514e-09	-8.454	3.514e-09	-8.454
Hfo_wHAsO4-	2.949e-09	-8.530	2.949e-09	-8.530
Hfo_wOBa+	5.381e-11	-10.269	5.381e-11	-10.269
Hfo_wH2AsO4	2.419e-11	-10.616	2.419e-11	-10.616

----------Solution composition----------

Elements	Molality	Moles
Ag	7.845e-08	7.844e-08
Al	5.089e-07	5.089e-07
As	2.132e-11	2.132e-11
Ba	2.354e-08	2.354e-08
C	2.349e-03	2.349e-03
Ca	7.603e-03	7.603e-03
Cd	5.408e-08	5.407e-08
Cl	9.930e-05	9.929e-05
Cu	5.245e-08	5.245e-08
F	5.465e-06	5.465e-06
Fe	8.156e-05	8.156e-05
K	4.176e-05	4.175e-05
Mg	9.841e-03	9.840e-03
Mn	4.105e-05	4.104e-05
N	5.052e-06	5.052e-06
Na	2.620e-03	2.620e-03
Ni	1.771e-07	1.771e-07
Pb	1.248e-12	1.248e-12
S	1.773e-02	1.773e-02
Si	5.492e-04	5.492e-04
Zn	2.054e-07	2.054e-07

----------Description of solution----------

pH = 7.435 Charge balance
pe = 0.000 Adjusted to redox equilibrium
Activity of water = 0.999

```
              Ionic strength  =   5.104e-02
          Mass of water (kg)  =   9.999e-01
     Total alkalinity (eq/kg)  =   2.242e-03
          Total CO2 (mol/kg)  =   2.349e-03
         Temperature (deg C)  =  10.000
      Electrical balance (eq)  =   1.931e-09
                  Iterations  =   1
                     Total H  = 1.110100e+02
                     Total O  = 5.558279e+01

Surface_model iteration: 1,   0 iterations
Surface_model iteration: 2,   0 iterations
-------------------------------Phase assemblage--------------------------------

                                                   Moles in assemblage
      Phase                SI log IAP  log KT    Initial      Final      Delta

      Al(OH)3(a)        -1.76    9.67   11.43  0.000e+00              0.000e+00
      Al4(OH)10SO4      -1.15   21.55   22.70  0.000e+00              0.000e+00
      Alunite           -0.80   -2.30   -1.50  0.000e+00              0.000e+00
      Anglesite         -7.74  -15.61   -7.87  0.000e+00              0.000e+00
      Antlerite        -10.73   -2.44    8.29  0.000e+00              0.000e+00
      Azurite          -10.67  -26.66  -16.00  0.000e+00              0.000e+00
      Barite             0.00  -10.22  -10.22  2.825e-06  3.532e-06  7.073e-07
      Boehmite           0.00    9.67    9.67  2.507e-05  2.649e-05  1.423e-06
      Brochantite      -12.88    2.46   15.34  0.000e+00              0.000e+00
      Ca3(AsO4)2:6H2O  -19.49    2.81   22.30  0.000e+00              0.000e+00
      Calcite            0.00   -8.41   -8.41  3.758e+00  3.761e+00  3.195e-03
      CO2(g)            -2.50  -20.68  -18.18  1.227e-02  1.636e-02  4.091e-03
      Ferrihydrite      -0.54   17.77   18.31  0.000e+00              0.000e+00
      Fix_e-             0.00    0.00    0.00
            O2                is reactant      1.000e+02  1.000e+02  7.480e-06
      Gypsum             0.00   -4.86   -4.86  1.066e-01  1.104e-01  3.832e-03
      Jarosite-K        -4.67   22.00   26.68  0.000e+00              0.000e+00
      Malachite         -6.31  -10.88   -4.57  0.000e+00              0.000e+00
      Otavite            0.00  -13.72  -13.72  2.568e-06  4.409e-06  1.841e-06
      Pyrite           -37.10 -128.01  -90.91  0.000e+00              0.000e+00
      Siderite           0.00  -10.34  -10.34  1.004e-04  1.345e-04  3.417e-05
      Smithsonite       -3.15  -12.98   -9.83  0.000e+00              0.000e+00
      ZnCO3:H2O         -2.72  -12.98  -10.26  0.000e+00              0.000e+00

------------------------------Surface composition------------------------------

Hfo
      -1.038e-10  Net surface charge, eq
      -3.092e-09  sigma, C/m**2
       1.864e-02  psi, V
      -7.642e-01  -F*psi/RT
       4.657e-01  exp(-F*psi/RT)
       6.000e+02  specific area, m**2/g
       5.400e+00  mass, g

      Kg water in diffuse layer: 3.240000e-02

      Total moles in diffuse layer (excluding water)

      Element             Moles
      Ag               2.3942e-09
      Al               1.6563e-08
      As               9.9033e-13
      Ba               6.5226e-10
      C                8.4210e-05
      Ca               2.2227e-04
      Cd               1.6451e-09
      Cl               3.6124e-06
      Cu               1.8896e-09
      F                1.9362e-07
      Fe               2.3594e-06
      H                1.5954e-04
      K                1.2467e-06
      Mg               2.8662e-04
```

Mn	1.1921e-06
N	1.5020e-07
Na	7.8164e-05
Ni	6.6485e-09
O	3.1158e-03
Pb	4.8496e-14
S	6.9798e-04
Si	1.7799e-05
Zn	7.7924e-09

Hfo_s

2.500e-04 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_sOHCa+2	2.051e-04	-3.688	2.051e-04	-3.688
Hfo_sOZn+	3.196e-05	-4.495	3.197e-05	-4.495
Hfo_sOH	3.990e-06	-5.399	3.990e-06	-5.399
Hfo_sOCu+	3.831e-06	-5.417	3.832e-06	-5.417
Hfo_sOCd+	1.689e-06	-5.772	1.689e-06	-5.772
Hfo_sOH2+	1.331e-06	-5.876	1.331e-06	-5.876
Hfo_sONi+	1.020e-06	-5.991	1.020e-06	-5.991
Hfo_sOHSO4-2	6.201e-07	-6.208	6.202e-07	-6.207
Hfo_sO-	2.740e-07	-6.562	2.740e-07	-6.562
Hfo_sOPb+	1.156e-07	-6.937	1.156e-07	-6.937
Hfo_sSO4-	1.037e-07	-6.984	1.038e-07	-6.984
Hfo_sOHBa+2	2.752e-09	-8.560	2.752e-09	-8.560
Hfo_sOHAsO4-3	5.590e-10	-9.253	5.591e-10	-9.253
Hfo_sH2AsO3	5.589e-12	-11.253	5.590e-12	-11.253
Hfo_sAsO4-2	2.697e-12	-11.569	2.698e-12	-11.569
Hfo_sHAsO4-	2.260e-12	-11.646	2.260e-12	-11.646
Hfo_sH2AsO4	1.851e-14	-13.733	1.851e-14	-13.733

Hfo_w

1.000e-02 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_wOH	6.082e-03	-2.216	6.082e-03	-2.216
Hfo_wOH2+	2.029e-03	-2.693	2.029e-03	-2.693
Hfo_wOHSO4-2	9.452e-04	-3.024	9.453e-04	-3.024
Hfo_wO-	4.176e-04	-3.379	4.177e-04	-3.379
Hfo_wOCa+	2.765e-04	-3.558	2.765e-04	-3.558
Hfo_wSO4-	1.581e-04	-3.801	1.581e-04	-3.801
Hfo_wOZn+	5.342e-05	-4.272	5.342e-05	-4.272
Hfo_wOCu+	3.284e-05	-4.484	3.284e-05	-4.484
Hfo_wONi+	3.480e-06	-5.458	3.481e-06	-5.458
Hfo_wOCd+	1.204e-06	-5.919	1.204e-06	-5.919
Hfo_wOHAsO4-3	8.521e-07	-6.070	8.522e-07	-6.069
Hfo_wH2AsO3	8.519e-09	-8.070	8.520e-09	-8.070
Hfo_wOPb+	6.857e-09	-8.164	6.857e-09	-8.164
Hfo_wAsO4-2	4.111e-09	-8.386	4.112e-09	-8.386
Hfo_wHAsO4-	3.445e-09	-8.463	3.445e-09	-8.463
Hfo_wOBa+	5.364e-11	-10.271	5.364e-11	-10.271
Hfo_wH2AsO4	2.821e-11	-10.550	2.821e-11	-10.550

----------Solution composition----------

Elements	Molality	Moles
Ag	7.845e-08	7.844e-08
Al	5.089e-07	5.089e-07
As	2.491e-11	2.491e-11
Ba	2.354e-08	2.354e-08
C	2.349e-03	2.349e-03
Ca	7.603e-03	7.603e-03
Cd	5.408e-08	5.407e-08
Cl	9.930e-05	9.929e-05
Cu	6.343e-08	6.343e-08
F	5.465e-06	5.464e-06
Fe	8.156e-05	8.156e-05

```
K                 4.176e-05   4.175e-05
Mg                9.841e-03   9.840e-03
Mn                4.105e-05   4.104e-05
N                 4.988e-06   4.988e-06
Na                2.620e-03   2.620e-03
Ni                2.096e-07   2.096e-07
Pb                1.512e-12   1.511e-12
S                 1.773e-02   1.773e-02
Si                5.492e-04   5.492e-04
Zn                2.586e-07   2.586e-07

----------------------------Description of solution----------------------------

                          pH  =   7.435      Charge balance
                          pe  =   0.000      Adjusted to redox equilibrium
            Activity of water  =   0.999
               Ionic strength  =   5.104e-02
           Mass of water (kg)  =   9.999e-01
      Total alkalinity (eq/kg)  =   2.242e-03
           Total CO2 (mol/kg)  =   2.349e-03
          Temperature (deg C)  =  10.000
       Electrical balance (eq)  =   5.010e-11
                   Iterations  =   0
                      Total H  = 1.110100e+02
                      Total O  = 5.558279e+01

Surface_model iteration: 1,   0 iterations
Surface_model iteration: 2,   0 iterations
-------------------------------Phase assemblage--------------------------------

                                                    Moles in assemblage
       Phase                SI log IAP  log KT    Initial      Final      Delta

       Al(OH)3(a)        -1.76    9.67   11.43  0.000e+00             0.000e+00
       Al4(OH)10SO4      -1.15   21.55   22.70  0.000e+00             0.000e+00
       Alunite           -0.80   -2.30   -1.50  0.000e+00             0.000e+00
       Anglesite         -7.67  -15.54   -7.87  0.000e+00             0.000e+00
       Antlerite        -10.52   -2.23    8.29  0.000e+00             0.000e+00
       Azurite          -10.46  -26.45  -16.00  0.000e+00             0.000e+00
       Barite             0.00  -10.22  -10.22  3.532e-06  4.239e-06  7.073e-07
       Boehmite           0.00    9.67    9.67  2.649e-05  2.791e-05  1.423e-06
       Brochantite      -12.60    2.74   15.34  0.000e+00             0.000e+00
       Ca3(AsO4)2:6H2O  -19.37    2.93   22.30  0.000e+00             0.000e+00
       Calcite            0.00   -8.41   -8.41  3.761e+00  3.764e+00  3.195e-03
       CO2(g)            -2.50  -20.68  -18.18  1.636e-02  2.045e-02  4.091e-03
       Ferrihydrite      -0.54   17.77   18.31  0.000e+00             0.000e+00
       Fix_e-             0.00    0.00    0.00
            O2                 is reactant      1.000e+02  1.000e+02  7.482e-06
       Gypsum             0.00   -4.86   -4.86  1.104e-01  1.143e-01  3.832e-03
       Jarosite-K        -4.67   22.00   26.68  0.000e+00             0.000e+00
       Malachite         -6.17  -10.74   -4.57  0.000e+00             0.000e+00
       Otavite            0.00  -13.72  -13.72  4.409e-06  6.248e-06  1.839e-06
       Pyrite           -37.10 -128.01  -90.91  0.000e+00             0.000e+00
       Siderite           0.00  -10.34  -10.34  1.345e-04  1.687e-04  3.417e-05
       Smithsonite       -3.07  -12.90   -9.83  0.000e+00             0.000e+00
       ZnCO3:H2O         -2.64  -12.90  -10.26  0.000e+00             0.000e+00

------------------------------Surface composition------------------------------

Hfo
        3.074e-11  Net surface charge, eq
        9.155e-10  sigma, C/m**2
        1.868e-02  psi, V
       -7.657e-01  -F*psi/RT
        4.650e-01  exp(-F*psi/RT)
        6.000e+02  specific area, m**2/g
        5.400e+00  mass, g

       Kg water in diffuse layer: 3.240000e-02

       Total moles in diffuse layer (excluding water)
```

Element	Moles
Ag	2.3940e-09
Al	1.6564e-08
As	1.1328e-12
Ba	6.5211e-10
C	8.4230e-05
Ca	2.2224e-04
Cd	1.6450e-09
Cl	3.6133e-06
Cu	2.2195e-09
F	1.9366e-07
Fe	2.3590e-06
H	1.5955e-04
K	1.2465e-06
Mg	2.8657e-04
Mn	1.1919e-06
N	1.5012e-07
Na	7.8153e-05
Ni	7.6514e-09
O	3.1173e-03
Pb	5.7361e-14
S	6.9834e-04
Si	1.7799e-05
Zn	9.4296e-09

Hfo_s

2.500e-04 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_sOHCa+2	1.990e-04	-3.701	1.990e-04	-3.701
Hfo_sOZn+	3.759e-05	-4.425	3.759e-05	-4.425
Hfo_sOCu+	4.374e-06	-5.359	4.374e-06	-5.359
Hfo_sOH	3.883e-06	-5.411	3.884e-06	-5.411
Hfo_sOCd+	1.641e-06	-5.785	1.641e-06	-5.785
Hfo_sOH2+	1.294e-06	-5.888	1.294e-06	-5.888
Hfo_sONi+	1.141e-06	-5.943	1.141e-06	-5.943
Hfo_sOHSO4-2	6.054e-07	-6.218	6.055e-07	-6.218
Hfo_sO-	2.671e-07	-6.573	2.671e-07	-6.573
Hfo_sOPb+	1.329e-07	-6.876	1.329e-07	-6.876
Hfo_sSO4-	1.011e-07	-6.995	1.011e-07	-6.995
Hfo_sOHBa+2	2.670e-09	-8.573	2.670e-09	-8.573
Hfo_sOHAsO4-3	6.249e-10	-9.204	6.250e-10	-9.204
Hfo_sH2AsO3	6.219e-12	-11.206	6.220e-12	-11.206
Hfo_sAsO4-2	3.011e-12	-11.521	3.011e-12	-11.521
Hfo_sHAsO4-	2.519e-12	-11.599	2.519e-12	-11.599
Hfo_sH2AsO4	2.060e-14	-13.686	2.060e-14	-13.686

Hfo_w

1.000e-02 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_wOH	6.071e-03	-2.217	6.071e-03	-2.217
Hfo_wOH2+	2.022e-03	-2.694	2.022e-03	-2.694
Hfo_wOHSO4-2	9.464e-04	-3.024	9.465e-04	-3.024
Hfo_wO-	4.175e-04	-3.379	4.176e-04	-3.379
Hfo_wOCa+	2.756e-04	-3.560	2.756e-04	-3.560
Hfo_wSO4-	1.581e-04	-3.801	1.581e-04	-3.801
Hfo_wOZn+	6.444e-05	-4.191	6.444e-05	-4.191
Hfo_wOCu+	3.845e-05	-4.415	3.845e-05	-4.415
Hfo_wONi+	3.992e-06	-5.399	3.992e-06	-5.399
Hfo_wOCd+	1.200e-06	-5.921	1.200e-06	-5.921
Hfo_wOHAsO4-3	9.770e-07	-6.010	9.770e-07	-6.010
Hfo_wH2AsO3	9.723e-09	-8.012	9.723e-09	-8.012
Hfo_wOPb+	8.084e-09	-8.092	8.084e-09	-8.092
Hfo_wAsO4-2	4.707e-09	-8.327	4.707e-09	-8.327
Hfo_wHAsO4-	3.938e-09	-8.405	3.938e-09	-8.405
Hfo_wOBa+	5.346e-11	-10.272	5.346e-11	-10.272
Hfo_wH2AsO4	3.220e-11	-10.492	3.220e-11	-10.492

```
-----------------------------Solution composition-----------------------------
```

Elements	Molality	Moles
Ag	7.845e-08	7.844e-08
Al	5.089e-07	5.089e-07
As	2.848e-11	2.848e-11
Ba	2.354e-08	2.354e-08
C	2.349e-03	2.349e-03
Ca	7.603e-03	7.603e-03
Cd	5.408e-08	5.407e-08
Cl	9.930e-05	9.929e-05
Cu	7.451e-08	7.451e-08
F	5.465e-06	5.464e-06
Fe	8.156e-05	8.156e-05
K	4.176e-05	4.175e-05
Mg	9.841e-03	9.840e-03
Mn	4.105e-05	4.104e-05
N	4.986e-06	4.986e-06
Na	2.620e-03	2.620e-03
Ni	2.413e-07	2.413e-07
Pb	1.788e-12	1.788e-12
S	1.773e-02	1.773e-02
Si	5.492e-04	5.492e-04
Zn	3.130e-07	3.130e-07

```
---------------------------Description of solution---------------------------

                            pH  =   7.435      Charge balance
                            pe  =   0.000      Adjusted to redox equilibrium
          Activity of water  =   0.999
             Ionic strength  =   5.104e-02
         Mass of water (kg)  =   9.999e-01
   Total alkalinity (eq/kg)  =   2.242e-03
        Total CO2 (mol/kg)   =   2.349e-03
      Temperature (deg C)    =  10.000
  Electrical balance (eq)    =  -1.038e-10
                Iterations   =   0
                   Total H   = 1.110100e+02
                   Total O   = 5.558279e+01

Surface_model iteration: 1,   0 iterations
Surface_model iteration: 2,   0 iterations
-------------------------------Phase assemblage--------------------------------
```

Phase	SI	log IAP	log KT	Moles in assemblage Initial	Final	Delta
Al(OH)3(a)	-1.76	9.67	11.43	0.000e+00		0.000e+00
Al4(OH)10SO4	-1.15	21.55	22.70	0.000e+00		0.000e+00
Alunite	-0.80	-2.30	-1.50	0.000e+00		0.000e+00
Anglesite	-7.60	-15.48	-7.87	0.000e+00		0.000e+00
Antlerite	-10.33	-2.04	8.29	0.000e+00		0.000e+00
Azurite	-10.28	-26.27	-16.00	0.000e+00		0.000e+00
Barite	0.00	-10.22	-10.22	4.239e-06	4.946e-06	7.073e-07
Boehmite	0.00	9.67	9.67	2.791e-05	2.934e-05	1.423e-06
Brochantite	-12.35	2.99	15.34	0.000e+00		0.000e+00
Ca3(AsO4)2:6H2O	-19.27	3.03	22.30	0.000e+00		0.000e+00
Calcite	0.00	-8.41	-8.41	3.764e+00	3.767e+00	3.195e-03
CO2(g)	-2.50	-20.68	-18.18	2.045e-02	2.454e-02	4.091e-03
Ferrihydrite	-0.54	17.77	18.31	0.000e+00		0.000e+00
Fix_e-	0.00	0.00	0.00			
CO2		is reactant		1.000e+02	1.000e+02	7.485e-06
Gypsum	0.00	-4.86	-4.86	1.143e-01	1.181e-01	3.832e-03
Jarosite-K	-4.67	22.00	26.68	0.000e+00		0.000e+00
Malachite	-6.05	-10.62	-4.57	0.000e+00		0.000e+00
Otavite	0.00	-13.72	-13.72	6.248e-06	8.086e-06	1.837e-06
Pyrite	-37.10	-128.01	-90.91	0.000e+00		0.000e+00
Siderite	0.00	-10.34	-10.34	1.687e-04	2.029e-04	3.417e-05
Smithsonite	-3.00	-12.83	-9.83	0.000e+00		0.000e+00

```
ZnCO3:H2O        -2.57  -12.83  -10.26  0.000e+00              0.000e+00

-----------------------------Surface composition-----------------------------

Hfo
        2.502e-12  Net surface charge, eq
        7.450e-11  sigma, C/m**2
        1.872e-02  psi, V
       -7.673e-01  -F*psi/RT
        4.643e-01  exp(-F*psi/RT)
        6.000e+02  specific area, m**2/g
        5.400e+00  mass, g

       Kg water in diffuse layer: 3.240000e-02

       Total moles in diffuse layer (excluding water)

       Element              Moles
       Ag                2.3938e-09
       Al                1.6564e-08
       As                1.2745e-12
       Ba                6.5196e-10
       C                 8.4251e-05
       Ca                2.2220e-04
       Cd                1.6449e-09
       Cl                3.6143e-06
       Cu                2.5525e-09
       F                 1.9370e-07
       Fe                2.3587e-06
       H                 1.5957e-04
       K                 1.2464e-06
       Mg                2.8653e-04
       Mn                1.1917e-06
       N                 1.5010e-07
       Na                7.8143e-05
       Ni                8.6247e-09
       O                 3.1189e-03
       Pb                6.6656e-14
       S                 6.9871e-04
       Si                1.7799e-05
       Zn                1.1099e-08

Hfo_s
        2.500e-04  moles
                                          Log                      Log
       Species                Moles      Moles    Molality    Molality

       Hfo_sOHCa+2        1.931e-04     -3.714   1.931e-04      -3.714
       Hfo_sOZn+          4.302e-05     -4.366   4.302e-05      -4.366
       Hfo_sOCu+          4.890e-06     -5.311   4.891e-06      -5.311
       Hfo_sOH            3.781e-06     -5.422   3.781e-06      -5.422
       Hfo_sOCd+          1.595e-06     -5.797   1.595e-06      -5.797
       Hfo_sOH2+          1.257e-06     -5.901   1.258e-06      -5.900
       Hfo_sONi+          1.250e-06     -5.903   1.250e-06      -5.903
       Hfo_sOHSO4-2       5.913e-07     -6.228   5.914e-07      -6.228
       Hfo_sO-            2.605e-07     -6.584   2.605e-07      -6.584
       Hfo_sOPb+          1.501e-07     -6.824   1.502e-07      -6.823
       Hfo_sSO4-          9.862e-08     -7.006   9.863e-08      -7.006
       Hfo_sOHBa+2        2.592e-09     -8.586   2.592e-09      -8.586
       Hfo_sOHAsO4-3      6.875e-10     -9.163   6.875e-10      -9.163
       Hfo_sH2AsO3        6.809e-12    -11.167   6.809e-12     -11.167
       Hfo_sAsO4-2        3.307e-12    -11.481   3.307e-12     -11.481
       Hfo_sHAsO4-        2.762e-12    -11.559   2.762e-12     -11.559
       Hfo_sH2AsO4        2.255e-14    -13.647   2.255e-14     -13.647

Hfo_w
        1.000e-02  moles
                                          Log                      Log
       Species                Moles      Moles    Molality    Molality

       Hfo_wOH            6.060e-03     -2.218   6.061e-03      -2.217
```

Hfo_wOH2+	2.015e-03	-2.696	2.016e-03	-2.696
Hfo_wOHSO4-2	9.478e-04	-3.023	9.478e-04	-3.023
Hfo_wO-	4.175e-04	-3.379	4.175e-04	-3.379
Hfo_wOCa+	2.747e-04	-3.561	2.747e-04	-3.561
Hfo_wSO4-	1.581e-04	-3.801	1.581e-04	-3.801
Hfo_wOZn+	7.560e-05	-4.121	7.560e-05	-4.121
Hfo_wOCu+	4.408e-05	-4.356	4.408e-05	-4.356
Hfo_wONi+	4.485e-06	-5.348	4.485e-06	-5.348
Hfo_wOCd+	1.196e-06	-5.922	1.196e-06	-5.922
Hfo_wOHAsO4-3	1.102e-06	-5.958	1.102e-06	-5.958
Hfo_wH2AsO3	1.091e-08	-7.962	1.091e-08	-7.962
Hfo_wOPb+	9.362e-09	-8.029	9.363e-09	-8.029
Hfo_wAsO4-2	5.300e-09	-8.276	5.300e-09	-8.276
Hfo_wHAsO4-	4.427e-09	-8.354	4.427e-09	-8.354
Hfo_wOBa+	5.328e-11	-10.273	5.328e-11	-10.273
Hfo_wH2AsO4	3.614e-11	-10.442	3.614e-11	-10.442

----------Solution composition----------

Elements	Molality	Moles
Ag	7.845e-08	7.844e-08
Al	5.089e-07	5.089e-07
As	3.203e-11	3.203e-11
Ba	2.354e-08	2.354e-08
C	2.349e-03	2.349e-03
Ca	7.603e-03	7.603e-03
Cd	5.408e-08	5.407e-08
Cl	9.930e-05	9.929e-05
Cu	8.571e-08	8.570e-08
F	5.465e-06	5.464e-06
Fe	8.156e-05	8.156e-05
K	4.176e-05	4.175e-05
Mg	9.841e-03	9.840e-03
Mn	4.105e-05	4.104e-05
N	4.986e-06	4.986e-06
Na	2.620e-03	2.620e-03
Ni	2.720e-07	2.719e-07
Pb	2.078e-12	2.077e-12
S	1.773e-02	1.773e-02
Si	5.492e-04	5.492e-04
Zn	3.684e-07	3.684e-07

----------Description of solution----------

```
                        pH  =   7.435      Charge balance
                        pe  =   0.000      Adjusted to redox equilibrium
            Activity of water  =   0.999
               Ionic strength  =   5.104e-02
            Mass of water (kg)  =   9.999e-01
      Total alkalinity (eq/kg)  =   2.242e-03
            Total CO2 (mol/kg)  =   2.349e-03
          Temperature (deg C)   =  10.000
     Electrical balance (eq)    =   3.074e-11
                 Iterations     =   0
                    Total H     = 1.110100e+02
                    Total O     = 5.558279e+01
```

Surface_model iteration: 1, 0 iterations
Surface_model iteration: 2, 1 iterations

----------Phase assemblage----------

Phase	SI	log IAP	log KT	Moles in assemblage Initial	Final	Delta
Al(OH)3(a)	-1.76	9.67	11.43	0.000e+00		0.000e+00
Al4(OH)10SO4	-1.15	21.55	22.70	0.000e+00		0.000e+00
Alunite	-0.80	-2.30	-1.50	0.000e+00		0.000e+00
Anglesite	-7.54	-15.42	-7.87	0.000e+00		0.000e+00
Antlerite	-10.17	-1.88	8.29	0.000e+00		0.000e+00
Azurite	-10.11	-26.11	-16.00	0.000e+00		0.000e+00

Barite	0.00	-10.22	-10.22	4.946e-06	5.653e-06	7.073e-07
Boehmite	0.00	9.67	9.67	2.934e-05	3.076e-05	1.423e-06
Brochantite	-12.14	3.20	15.34	0.000e+00		0.000e+00
Ca3(AsO4)2:6H2O	-19.18	3.12	22.30	0.000e+00		0.000e+00
Calcite	0.00	-8.41	-8.41	3.767e+00	3.770e+00	3.195e-03
CO2(g)	-2.50	-20.68	-18.18	2.454e-02	2.864e-02	4.091e-03
Ferrihydrite	-0.54	17.77	18.31	0.000e+00		0.000e+00
Fix_e-	0.00	0.00	0.00			
O2		is reactant		1.000e+02	1.000e+02	7.488e-06
Gypsum	0.00	-4.86	-4.86	1.181e-01	1.219e-01	3.832e-03
Jarosite-K	-4.67	22.00	26.68	0.000e+00		0.000e+00
Malachite	-5.94	-10.51	-4.57	0.000e+00		0.000e+00
Otavite	0.00	-13.72	-13.72	8.085e-06	9.921e-06	1.836e-06
Pyrite	-37.10	-128.01	-90.91	0.000e+00		0.000e+00
Siderite	0.00	-10.34	-10.34	2.029e-04	2.370e-04	3.417e-05
Smithsonite	-2.93	-12.76	-9.83	0.000e+00		0.000e+00
ZnCO3:H2O	-2.50	-12.76	-10.26	0.000e+00		0.000e+00

----------Surface composition----------

Hfo

-7.752e-12	Net surface charge, eq
-2.309e-10	sigma, C/m**2
1.876e-02	psi, V
-7.689e-01	-F*psi/RT
4.635e-01	exp(-F*psi/RT)
6.000e+02	specific area, m**2/g
5.400e+00	mass, g

Kg water in diffuse layer: 3.240000e-02

Total moles in diffuse layer (excluding water)

Element	Moles
Ag	2.3936e-09
Al	1.6564e-08
As	1.4153e-12
Ba	6.5180e-10
C	8.4272e-05
Ca	2.2217e-04
Cd	1.6448e-09
Cl	3.6152e-06
Cu	2.8886e-09
F	1.9375e-07
Fe	2.3583e-06
H	1.5959e-04
K	1.2462e-06
Mg	2.8648e-04
Mn	1.1915e-06
N	1.5008e-07
Na	7.8132e-05
Ni	9.5684e-09
O	3.1205e-03
Pb	7.6390e-14
S	6.9910e-04
Si	1.7799e-05
Zn	1.2801e-08

Hfo_s

2.500e-04 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_sOHCa+2	1.875e-04	-3.727	1.875e-04	-3.727
Hfo_sOZn+	4.825e-05	-4.317	4.825e-05	-4.316
Hfo_sOCu+	5.382e-06	-5.269	5.383e-06	-5.269
Hfo_sOH	3.683e-06	-5.434	3.683e-06	-5.434
Hfo_sOCd+	1.551e-06	-5.809	1.551e-06	-5.809
Hfo_sONi+	1.348e-06	-5.870	1.349e-06	-5.870
Hfo_sOH2+	1.223e-06	-5.913	1.223e-06	-5.913
Hfo_sOHSO4-2	5.778e-07	-6.238	5.779e-07	-6.238

Hfo_sO-	2.541e-07	-6.595	2.541e-07	-6.595
Hfo_sOPb+	1.673e-07	-6.776	1.673e-07	-6.776
Hfo_sSO4-	9.621e-08	-7.017	9.622e-08	-7.017
Hfo_sOHBa+2	2.516e-09	-8.599	2.516e-09	-8.599
Hfo_sOHAsO4-3	7.468e-10	-9.127	7.469e-10	-9.127
Hfo_sH2AsO3	7.360e-12	-11.133	7.361e-12	-11.133
Hfo_sAsO4-2	3.586e-12	-11.445	3.586e-12	-11.445
Hfo_sHAsO4-	2.991e-12	-11.524	2.991e-12	-11.524
Hfo_sH2AsO4	2.438e-14	-13.613	2.438e-14	-13.613

Hfo_w

1.000e-02 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_wOH	6.049e-03	-2.218	6.050e-03	-2.218
Hfo_wOH2+	2.008e-03	-2.697	2.009e-03	-2.697
Hfo_wOHSO4-2	9.492e-04	-3.023	9.492e-04	-3.023
Hfo_wO-	4.174e-04	-3.379	4.174e-04	-3.379
Hfo_wOCa+	2.737e-04	-3.563	2.737e-04	-3.563
Hfo_wSO4-	1.580e-04	-3.801	1.580e-04	-3.801
Hfo_wOZn+	8.690e-05	-4.061	8.690e-05	-4.061
Hfo_wOCu+	4.972e-05	-4.304	4.972e-05	-4.303
Hfo_wONi+	4.959e-06	-5.305	4.959e-06	-5.305
Hfo_wOHAsO4-3	1.227e-06	-5.911	1.227e-06	-5.911
Hfo_wOCd+	1.192e-06	-5.924	1.192e-06	-5.924
Hfo_wH2AsO3	1.209e-08	-7.918	1.209e-08	-7.918
Hfo_wOPb+	1.069e-08	-7.971	1.069e-08	-7.971
Hfo_wAsO4-2	5.891e-09	-8.230	5.891e-09	-8.230
Hfo_wHAsO4-	4.913e-09	-8.309	4.913e-09	-8.309
Hfo_wOBa+	5.309e-11	-10.275	5.310e-11	-10.275
Hfo_wH2AsO4	4.004e-11	-10.398	4.004e-11	-10.397

----------Solution composition----------

Elements	Molality	Moles
Ag	7.845e-08	7.844e-08
Al	5.089e-07	5.089e-07
As	3.555e-11	3.554e-11
Ba	2.354e-08	2.354e-08
C	2.349e-03	2.349e-03
Ca	7.603e-03	7.603e-03
Cd	5.408e-08	5.407e-08
Cl	9.930e-05	9.929e-05
Cu	9.701e-08	9.700e-08
F	5.465e-06	5.464e-06
Fe	8.156e-05	8.156e-05
K	4.176e-05	4.175e-05
Mg	9.841e-03	9.840e-03
Mn	4.105e-05	4.104e-05
N	4.986e-06	4.986e-06
Na	2.620e-03	2.620e-03
Ni	3.017e-07	3.017e-07
Pb	2.381e-12	2.381e-12
S	1.773e-02	1.773e-02
Si	5.492e-04	5.492e-04
Zn	4.250e-07	4.249e-07

----------Description of solution----------

pH	=	7.435	Charge balance
pe	=	0.000	Adjusted to redox equilibrium
Activity of water	=	0.999	
Ionic strength	=	5.104e-02	
Mass of water (kg)	=	9.999e-01	
Total alkalinity (eq/kg)	=	2.243e-03	
Total CO2 (mol/kg)	=	2.349e-03	
Temperature (deg C)	=	10.000	
Electrical balance (eq)	=	2.502e-12	
Iterations	=	1	

```
                    Total H  = 1.110100e+02
                    Total O  = 5.558279e+01

Surface_model iteration: 1,   0 iterations
Surface_model iteration: 2,   1 iterations
-------------------------------Phase assemblage--------------------------------

                                                    Moles in assemblage
       Phase                SI log IAP  log KT    Initial      Final      Delta

       Al(OH)3(a)        -1.76    9.67   11.43  0.000e+00              0.000e+00
       Al4(OH)10SO4      -1.15   21.55   22.70  0.000e+00              0.000e+00
       Alunite           -0.80   -2.30   -1.50  0.000e+00              0.000e+00
       Anglesite         -7.49  -15.36   -7.87  0.000e+00              0.000e+00
       Antlerite        -10.03   -1.74    8.29  0.000e+00              0.000e+00
       Azurite           -9.97  -25.97  -16.00  0.000e+00              0.000e+00
       Barite             0.00  -10.22  -10.22  5.653e-06  6.361e-06  7.073e-07
       Boehmite           0.00    9.67    9.67  3.076e-05  3.218e-05  1.423e-06
       Brochantite      -11.95    3.39   15.34  0.000e+00              0.000e+00
       Ca3(AsO4)2:6H2O  -19.10    3.20   22.30  0.000e+00              0.000e+00
       Calcite            0.00   -8.41   -8.41  3.770e+00  3.774e+00  3.195e-03
       CO2(g)            -2.50  -20.68  -18.18  2.864e-02  3.273e-02  4.091e-03
       Ferrihydrite      -0.54   17.77   18.31  0.000e+00              0.000e+00
       Fix_e-             0.00    0.00    0.00
              O2                is reactant     1.000e+02  1.000e+02  7.491e-06
       Gypsum             0.00   -4.86   -4.86  1.219e-01  1.258e-01  3.831e-03
       Jarosite-K        -4.67   22.00   26.68  0.000e+00              0.000e+00
       Malachite         -5.84  -10.42   -4.57  0.000e+00              0.000e+00
       Otavite            0.00  -13.72  -13.72  9.921e-06  1.175e-05  1.834e-06
       Pyrite           -37.10 -128.01  -90.91  0.000e+00              0.000e+00
       Siderite           0.00  -10.34  -10.34  2.370e-04  2.712e-04  3.417e-05
       Smithsonite       -2.88  -12.71   -9.83  0.000e+00              0.000e+00
       ZnCO3:H2O         -2.45  -12.71  -10.26  0.000e+00              0.000e+00

------------------------------Surface composition------------------------------

Hfo
       -8.025e-12  Net surface charge, eq
       -2.390e-10  sigma, C/m**2
        1.880e-02  psi, V
       -7.706e-01  -F*psi/RT
        4.627e-01  exp(-F*psi/RT)
        6.000e+02  specific area, m**2/g
        5.400e+00  mass, g

       Kg water in diffuse layer: 3.240000e-02

       Total moles in diffuse layer (excluding water)

       Element             Moles
       Ag               2.3934e-09
       Al               1.6564e-08
       As               1.5553e-12
       Ba               6.5164e-10
       C                8.4294e-05
       Ca               2.2213e-04
       Cd               1.6446e-09
       Cl               3.6163e-06
       Cu               3.2278e-09
       F                1.9379e-07
       Fe               2.3578e-06
       H                1.5962e-04
       K                1.2460e-06
       Mg               2.8644e-04
       Mn               1.1913e-06
       N                1.5007e-07
       Na               7.8120e-05
       Ni               1.0483e-08
       O                3.1221e-03
       Pb               8.6570e-14
       S                6.9949e-04
```

Si	1.7799e-05
Zn	1.4535e-08

Hfo_s

2.500e-04 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_sOHCa+2	1.820e-04	-3.740	1.821e-04	-3.740
Hfo_sOZn+	5.329e-05	-4.273	5.329e-05	-4.273
Hfo_sOCu+	5.851e-06	-5.233	5.851e-06	-5.233
Hfo_sOH	3.588e-06	-5.445	3.589e-06	-5.445
Hfo_sOCd+	1.509e-06	-5.821	1.509e-06	-5.821
Hfo_sONi+	1.437e-06	-5.843	1.437e-06	-5.843
Hfo_sOH2+	1.189e-06	-5.925	1.189e-06	-5.925
Hfo_sOHSO4-2	5.649e-07	-6.248	5.650e-07	-6.248
Hfo_sO-	2.480e-07	-6.606	2.480e-07	-6.606
Hfo_sOPb+	1.844e-07	-6.734	1.845e-07	-6.734
Hfo_sSO4-	9.390e-08	-7.027	9.391e-08	-7.027
Hfo_sOHBa+2	2.443e-09	-8.612	2.443e-09	-8.612
Hfo_sOHAsO4-3	8.032e-10	-9.095	8.033e-10	-9.095
Hfo_sH2AsO3	7.876e-12	-11.104	7.877e-12	-11.104
Hfo_sAsO4-2	3.850e-12	-11.414	3.851e-12	-11.414
Hfo_sHAsO4-	3.206e-12	-11.494	3.206e-12	-11.494
Hfo_sH2AsO4	2.608e-14	-13.584	2.608e-14	-13.584

Hfo_w

1.000e-02 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_wOH	6.038e-03	-2.219	6.039e-03	-2.219
Hfo_wOH2+	2.001e-03	-2.699	2.002e-03	-2.699
Hfo_wOHSO4-2	9.506e-04	-3.022	9.507e-04	-3.022
Hfo_wO-	4.173e-04	-3.380	4.174e-04	-3.379
Hfo_wOCa+	2.728e-04	-3.564	2.728e-04	-3.564
Hfo_wSO4-	1.580e-04	-3.801	1.580e-04	-3.801
Hfo_wOZn+	9.833e-05	-4.007	9.833e-05	-4.007
Hfo_wOCu+	5.537e-05	-4.257	5.537e-05	-4.257
Hfo_wONi+	5.414e-06	-5.267	5.414e-06	-5.266
Hfo_wOHAsO4-3	1.352e-06	-5.869	1.352e-06	-5.869
Hfo_wOCd+	1.188e-06	-5.925	1.188e-06	-5.925
Hfo_wH2AsO3	1.325e-08	-7.878	1.325e-08	-7.878
Hfo_wOPb+	1.207e-08	-7.918	1.208e-08	-7.918
Hfo_wAsO4-2	6.479e-09	-8.188	6.480e-09	-8.188
Hfo_wHAsO4-	5.395e-09	-8.268	5.395e-09	-8.268
Hfo_wOBa+	5.291e-11	-10.276	5.291e-11	-10.276
Hfo_wH2AsO4	4.389e-11	-10.358	4.389e-11	-10.358

----------Solution composition----------

Elements	Molality	Moles
Ag	7.845e-08	7.844e-08
Al	5.089e-07	5.089e-07
As	3.904e-11	3.904e-11
Ba	2.354e-08	2.354e-08
C	2.349e-03	2.349e-03
Ca	7.603e-03	7.603e-03
Cd	5.408e-08	5.407e-08
Cl	9.930e-05	9.929e-05
Cu	1.084e-07	1.084e-07
F	5.465e-06	5.464e-06
Fe	8.156e-05	8.156e-05
K	4.176e-05	4.175e-05
Mg	9.841e-03	9.840e-03
Mn	4.105e-05	4.104e-05
N	4.986e-06	4.986e-06
Na	2.620e-03	2.620e-03
Ni	3.306e-07	3.306e-07
Pb	2.698e-12	2.698e-12

```
S                  1.773e-02   1.773e-02
Si                 5.492e-04   5.492e-04
Zn                 4.826e-07   4.825e-07

----------------------------Description of solution----------------------------

                          pH  =   7.435      Charge balance
                          pe  =   0.000      Adjusted to redox equilibrium
            Activity of water  =   0.999
               Ionic strength  =   5.104e-02
           Mass of water (kg)  =   9.999e-01
     Total alkalinity (eq/kg)  =   2.243e-03
           Total CO2 (mol/kg)  =   2.349e-03
          Temperature (deg C)  =  10.000
      Electrical balance (eq)  =  -7.752e-12
                  Iterations  =   1
                     Total H  = 1.110100e+02
                     Total O  = 5.558279e+01

Surface_model iteration: 1,   0 iterations
Surface_model iteration: 2,   1 iterations
-------------------------------Phase assemblage--------------------------------

                                                   Moles in assemblage
Phase                SI log IAP  log KT    Initial      Final      Delta

Al(OH)3(a)        -1.76    9.67   11.43  0.000e+00              0.000e+00
Al4(OH)10SO4      -1.15   21.55   22.70  0.000e+00              0.000e+00
Alunite           -0.80   -2.30   -1.50  0.000e+00              0.000e+00
Anglesite         -7.44  -15.31   -7.87  0.000e+00              0.000e+00
Antlerite         -9.90   -1.61    8.29  0.000e+00              0.000e+00
Azurite           -9.84  -25.83  -16.00  0.000e+00              0.000e+00
Barite             0.00  -10.22  -10.22  6.360e-06  7.068e-06  7.073e-07
Boehmite           0.00    9.67    9.67  3.218e-05  3.361e-05  1.423e-06
Brochantite      -11.77    3.57   15.34  0.000e+00              0.000e+00
Ca3(AsO4)2:6H2O  -19.02    3.28   22.30  0.000e+00              0.000e+00
Calcite            0.00   -8.41   -8.41  3.774e+00  3.777e+00  3.195e-03
CO2(g)            -2.50  -20.68  -18.18  3.273e-02  3.682e-02  4.091e-03
Ferrihydrite      -0.54   17.77   18.31  0.000e+00              0.000e+00
Fix_e-             0.00    0.00    0.00
      O2                 is reactant      1.000e+02  1.000e+02  7.493e-06
Gypsum             0.00   -4.86   -4.86  1.258e-01  1.296e-01  3.831e-03
Jarosite-K        -4.67   22.00   26.68  0.000e+00              0.000e+00
Malachite         -5.76  -10.33   -4.57  0.000e+00              0.000e+00
Otavite            0.00  -13.72  -13.72  1.175e-05  1.359e-05  1.832e-06
Pyrite           -37.10 -128.01  -90.91  0.000e+00              0.000e+00
Siderite           0.00  -10.34  -10.34  2.712e-04  3.054e-04  3.417e-05
Smithsonite       -2.83  -12.66   -9.83  0.000e+00              0.000e+00
ZnCO3:H2O         -2.40  -12.66  -10.26  0.000e+00              0.000e+00

------------------------------Surface composition------------------------------

Hfo
        -8.290e-12  Net surface charge, eq
        -2.469e-10  sigma, C/m**2
         1.884e-02  psi, V
        -7.724e-01  -F*psi/RT
         4.619e-01  exp(-F*psi/RT)
         6.000e+02  specific area, m**2/g
         5.400e+00  mass, g

        Kg water in diffuse layer: 3.240000e-02

        Total moles in diffuse layer (excluding water)

        Element             Moles
        Ag               2.3931e-09
        Al               1.6564e-08
        As               1.6943e-12
        Ba               6.5147e-10
        C                8.4317e-05
```

Ca	2.2210e-04
Cd	1.6445e-09
Cl	3.6173e-06
Cu	3.5701e-09
F	1.9384e-07
Fe	2.3574e-06
H	1.5964e-04
K	1.2458e-06
Mg	2.8639e-04
Mn	1.1911e-06
N	1.5005e-07
Na	7.8109e-05
Ni	1.1368e-08
O	3.1238e-03
Pb	9.7205e-14
S	6.9990e-04
Si	1.7799e-05
Zn	1.6300e-08

Hfo_s

2.500e-04 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_sOHCa+2	1.768e-04	-3.752	1.768e-04	-3.752
Hfo_sOZn+	5.815e-05	-4.235	5.816e-05	-4.235
Hfo_sOCu+	6.298e-06	-5.201	6.298e-06	-5.201
Hfo_sOH	3.498e-06	-5.456	3.498e-06	-5.456
Hfo_sONi+	1.516e-06	-5.819	1.516e-06	-5.819
Hfo_sOCd+	1.468e-06	-5.833	1.468e-06	-5.833
Hfo_sOH2+	1.157e-06	-5.937	1.157e-06	-5.937
Hfo_sOHSO4-2	5.526e-07	-6.258	5.526e-07	-6.258
Hfo_sO-	2.422e-07	-6.616	2.422e-07	-6.616
Hfo_sOPb+	2.015e-07	-6.696	2.015e-07	-6.696
Hfo_sSO4-	9.169e-08	-7.038	9.169e-08	-7.038
Hfo_sOHBa+2	2.373e-09	-8.625	2.373e-09	-8.625
Hfo_sOHAsO4-3	8.568e-10	-9.067	8.569e-10	-9.067
Hfo_sH2AsO3	8.358e-12	-11.078	8.359e-12	-11.078
Hfo_sAsO4-2	4.100e-12	-11.387	4.101e-12	-11.387
Hfo_sHAsO4-	3.408e-12	-11.468	3.408e-12	-11.467
Hfo_sH2AsO4	2.768e-14	-13.558	2.768e-14	-13.558

Hfo_w

1.000e-02 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_wOH	6.027e-03	-2.220	6.027e-03	-2.220
Hfo_wOH2+	1.994e-03	-2.700	1.994e-03	-2.700
Hfo_wOHSO4-2	9.522e-04	-3.021	9.522e-04	-3.021
Hfo_wO-	4.173e-04	-3.380	4.173e-04	-3.380
Hfo_wOCa+	2.718e-04	-3.566	2.718e-04	-3.566
Hfo_wSO4-	1.580e-04	-3.801	1.580e-04	-3.801
Hfo_wOZn+	1.099e-04	-3.959	1.099e-04	-3.959
Hfo_wOCu+	6.103e-05	-4.214	6.103e-05	-4.214
Hfo_wONi+	5.850e-06	-5.233	5.850e-06	-5.233
Hfo_wOHAsO4-3	1.477e-06	-5.831	1.477e-06	-5.831
Hfo_wOCd+	1.183e-06	-5.927	1.183e-06	-5.927
Hfo_wH2AsO3	1.440e-08	-7.842	1.440e-08	-7.842
Hfo_wOPb+	1.351e-08	-7.869	1.351e-08	-7.869
Hfo_wAsO4-2	7.066e-09	-8.151	7.066e-09	-8.151
Hfo_wHAsO4-	5.873e-09	-8.231	5.873e-09	-8.231
Hfo_wOBa+	5.272e-11	-10.278	5.272e-11	-10.278
Hfo_wH2AsO4	4.770e-11	-10.321	4.770e-11	-10.321

----------Solution composition----------

Elements	Molality	Moles
Ag	7.845e-08	7.844e-08
Al	5.089e-07	5.089e-07

As	4.250e-11	4.250e-11
Ba	2.354e-08	2.354e-08
C	2.349e-03	2.349e-03
Ca	7.603e-03	7.603e-03
Cd	5.408e-08	5.407e-08
Cl	9.930e-05	9.929e-05
Cu	1.199e-07	1.199e-07
F	5.465e-06	5.464e-06
Fe	8.156e-05	8.156e-05
K	4.176e-05	4.175e-05
Mg	9.841e-03	9.840e-03
Mn	4.105e-05	4.104e-05
N	4.986e-06	4.986e-06
Na	2.620e-03	2.620e-03
Ni	3.585e-07	3.585e-07
Pb	3.030e-12	3.030e-12
S	1.773e-02	1.773e-02
Si	5.492e-04	5.492e-04
Zn	5.412e-07	5.412e-07

----------Description of solution----------

```
                          pH  =   7.435      Charge balance
                          pe  =   0.000      Adjusted to redox equilibrium
            Activity of water  =   0.999
               Ionic strength  =   5.104e-02
           Mass of water (kg)  =   9.999e-01
     Total alkalinity (eq/kg)  =   2.243e-03
           Total CO2 (mol/kg)  =   2.349e-03
          Temperature (deg C)  =  10.000
      Electrical balance (eq)  =  -8.025e-12
                  Iterations  =   1
                     Total H  = 1.110100e+02
                     Total O  = 5.558280e+01

Surface_model iteration: 1,   0 iterations
Surface_model iteration: 2,   1 iterations
```

----------Phase assemblage----------

Phase	SI	log IAP	log KT	Moles in assemblage Initial	Final	Delta
Al(OH)3(a)	-1.76	9.67	11.43	0.000e+00		0.000e+00
Al4(OH)10SO4	-1.15	21.55	22.70	0.000e+00		0.000e+00
Alunite	-0.80	-2.30	-1.50	0.000e+00		0.000e+00
Anglesite	-7.39	-15.26	-7.87	0.000e+00		0.000e+00
Antlerite	-9.78	-1.49	8.29	0.000e+00		0.000e+00
Azurite	-9.72	-25.71	-16.00	0.000e+00		0.000e+00
Barite	0.00	-10.22	-10.22	7.068e-06	7.775e-06	7.073e-07
Boehmite	0.00	9.67	9.67	3.361e-05	3.503e-05	1.423e-06
Brochantite	-11.61	3.73	15.34	0.000e+00		0.000e+00
Ca3(AsO4)2:6H2O	-18.95	3.35	22.30	0.000e+00		0.000e+00
Calcite	0.00	-8.41	-8.41	3.777e+00	3.780e+00	3.195e-03
CO2(g)	-2.50	-20.68	-18.18	3.682e-02	4.091e-02	4.091e-03
Ferrihydrite	-0.54	17.77	18.31	0.000e+00		0.000e+00
Fix_e-	0.00	0.00	0.00			
O2		is reactant		1.000e+02	1.000e+02	7.496e-06
Gypsum	0.00	-4.86	-4.86	1.296e-01	1.334e-01	3.831e-03
Jarosite-K	-4.67	22.00	26.68	0.000e+00		0.000e+00
Malachite	-5.68	-10.25	-4.57	0.000e+00		0.000e+00
Otavite	0.00	-13.72	-13.72	1.359e-05	1.542e-05	1.831e-06
Pyrite	-37.10	-128.01	-90.91	0.000e+00		0.000e+00
Siderite	0.00	-10.34	-10.34	3.054e-04	3.395e-04	3.417e-05
Smithsonite	-2.78	-12.61	-9.83	0.000e+00		0.000e+00
ZnCO3:H2O	-2.35	-12.61	-10.26	0.000e+00		0.000e+00

----------Surface composition----------

```
Hfo
       -8.553e-12  Net surface charge, eq
       -2.547e-10  sigma, C/m**2
```

```
 1.889e-02  psi, V
-7.742e-01  -F*psi/RT
 4.611e-01  exp(-F*psi/RT)
 6.000e+02  specific area, m**2/g
 5.400e+00  mass, g

Kg water in diffuse layer: 3.240000e-02

Total moles in diffuse layer (excluding water)

Element              Moles
Ag                2.3929e-09
Al                1.6565e-08
As                1.8324e-12
Ba                6.5130e-10
C                 8.4340e-05
Ca                2.2206e-04
Cd                1.6444e-09
Cl                3.6183e-06
Cu                3.9154e-09
F                 1.9388e-07
Fe                2.3570e-06
H                 1.5966e-04
K                 1.2456e-06
Mg                2.8634e-04
Mn                1.1909e-06
N                 1.5003e-07
Na                7.8097e-05
Ni                1.2224e-08
O                 3.1255e-03
Pb                1.0830e-13
S                 7.0032e-04
Si                1.7799e-05
Zn                1.8094e-08

Hfo_s
 2.500e-04  moles
```

Species	Moles	Log Moles	Molality	Log Molality
Hfo_sOHCa+2	1.718e-04	-3.765	1.718e-04	-3.765
Hfo_sOZn+	6.284e-05	-4.202	6.284e-05	-4.202
Hfo_sOCu+	6.724e-06	-5.172	6.724e-06	-5.172
Hfo_sOH	3.410e-06	-5.467	3.410e-06	-5.467
Hfo_sONi+	1.587e-06	-5.799	1.587e-06	-5.799
Hfo_sOCd+	1.429e-06	-5.845	1.429e-06	-5.845
Hfo_sOH2+	1.126e-06	-5.948	1.126e-06	-5.948
Hfo_sOHSO4-2	5.407e-07	-6.267	5.407e-07	-6.267
Hfo_sO-	2.365e-07	-6.626	2.366e-07	-6.626
Hfo_sOPb+	2.185e-07	-6.660	2.185e-07	-6.660
Hfo_sSO4-	8.956e-08	-7.048	8.956e-08	-7.048
Hfo_sOHBa+2	2.306e-09	-8.637	2.306e-09	-8.637
Hfo_sOHAsO4-3	9.078e-10	-9.042	9.079e-10	-9.042
Hfo_sH2AsO3	8.809e-12	-11.055	8.809e-12	-11.055
Hfo_sAsO4-2	4.337e-12	-11.363	4.337e-12	-11.363
Hfo_sHAsO4-	3.598e-12	-11.444	3.598e-12	-11.444
Hfo_sH2AsO4	2.917e-14	-13.535	2.917e-14	-13.535

Hfo_w
 1.000e-02 moles

Species	Moles	Log Moles	Molality	Log Molality
Hfo_wOH	6.016e-03	-2.221	6.016e-03	-2.221
Hfo_wOH2+	1.987e-03	-2.702	1.987e-03	-2.702
Hfo_wOHSO4-2	9.538e-04	-3.021	9.539e-04	-3.021
Hfo_wO-	4.173e-04	-3.380	4.173e-04	-3.380
Hfo_wOCa+	2.708e-04	-3.567	2.708e-04	-3.567
Hfo_wSO4-	1.580e-04	-3.801	1.580e-04	-3.801
Hfo_wOZn+	1.215e-04	-3.915	1.216e-04	-3.915
Hfo_wOCu+	6.670e-05	-4.176	6.670e-05	-4.176

```
        Hfo_wONi+          6.268e-06      -5.203   6.268e-06      -5.203
        Hfo_wOHAsO4-3      1.601e-06      -5.795   1.602e-06      -5.795
        Hfo_wOCd+          1.179e-06      -5.928   1.179e-06      -5.928
        Hfo_wH2AsO3        1.554e-08      -7.809   1.554e-08      -7.809
        Hfo_wOPb+          1.500e-08      -7.824   1.500e-08      -7.824
        Hfo_wAsO4-2        7.650e-09      -8.116   7.651e-09      -8.116
        Hfo_wHAsO4-        6.347e-09      -8.197   6.347e-09      -8.197
        Hfo_wOBa+          5.253e-11     -10.280   5.253e-11     -10.280
        Hfo_wH2AsO4        5.146e-11     -10.289   5.146e-11     -10.289

-----------------------------Solution composition-----------------------------

        Elements            Molality       Moles

        Ag                 7.845e-08   7.844e-08
        Al                 5.089e-07   5.089e-07
        As                 4.594e-11   4.594e-11
        Ba                 2.354e-08   2.354e-08
        C                  2.349e-03   2.349e-03
        Ca                 7.603e-03   7.603e-03
        Cd                 5.408e-08   5.407e-08
        Cl                 9.930e-05   9.929e-05
        Cu                 1.316e-07   1.315e-07
        F                  5.465e-06   5.464e-06
        Fe                 8.156e-05   8.156e-05
        K                  4.176e-05   4.175e-05
        Mg                 9.841e-03   9.840e-03
        Mn                 4.105e-05   4.104e-05
        N                  4.986e-06   4.986e-06
        Na                 2.620e-03   2.620e-03
        Ni                 3.855e-07   3.855e-07
        Pb                 3.376e-12   3.376e-12
        S                  1.773e-02   1.773e-02
        Si                 5.492e-04   5.492e-04
        Zn                 6.008e-07   6.008e-07

----------------------------Description of solution----------------------------

                            pH  =   7.435      Charge balance
                            pe  =   0.000      Adjusted to redox equilibrium
              Activity of water  =   0.999
                 Ionic strength  =   5.104e-02
            Mass of water (kg)   =   9.999e-01
      Total alkalinity (eq/kg)   =   2.243e-03
            Total CO2 (mol/kg)   =   2.349e-03
          Temperature (deg C)    =  10.000
       Electrical balance (eq)   =  -8.290e-12
                   Iterations    =   1
                      Total H    = 1.110100e+02
                      Total O    = 5.558280e+01

------------------
End of simulation.
------------------

-------------------------------------
Reading input data for simulation 19.
-------------------------------------

-----------
End of run.
-----------
```

WMP-130-89-019B
3809 (135)

March 18, 1998

FEDEX

To: Tom Olsen, NV-920
Paul Summers, NARSC-210
Marcia Knadle, EPA-OEA-095

From: George Brown, Spokane District (Bureau of Land Management)

Subject: Lamefoot Mine - plan modification review

Echo Bay delivered the impact evaluation document today. Please note that the document is inappropriately title "Worst Case Impact Evaluation for the Proposed Interim Expansion for the Lamefoot Mine."

BLM's concern was that previous studies and models by Echo Bay focused on the most favorable conclusions that could be reached, while tending to omit or downplay data and test results that indicated the operations could possibly result in greater impacts. In addition, actual site conditions during mining deviated substantially from the conditions predicted in previous studies (i.e., more potentially acid generating waste rock; greater hydraulic conductivity in fractures). As a result, BLM required Echo Bay to use all the actual test results, data and probable post-closure conditions to identify the reasonable range of impacts that are likely to occur as a result of the expansion. Echo Bay refers to BLM's requirement as a "worst case", whereas the conditions addressed are actually for the most probable case.

The hydrogeology evaluation is supposed to identify any preferential pathways for groundwater movement, and the actual groundwater situation at present, which includes the actual drawdown impacts from existing mine workings and underground exploration drilling.

The groundwater refilling model is supposed to evaluate the likely groundwater drawdown that will result from outflow through the crown pillar and faults/fractures, the potential impacts to wetlands during operations from drawdown, the potential post-closure drawdown area that may influence geochemistry and groundwater quality, and the potential post-closure outflow pathways for groundwater movement.

The geochemical model is supposed to evaluate the effect mining on post-closure groundwater quality, based on the amount of potentially acid generating (PAG) rock in the crown pillar and wall rock, the actual amount backfilling to date with PAG waste rock, plus the additional PAG waste rock to be excavated and backfilled from the expansion. The model is supposed to consider the effect of mine workings being exposed to oxidation perpetually within the post-closure groundwater drawdown area. The geochemical evaluation is supposed to evaluate the impact of transport outside the project area.

The models are supposed to include sensitivity analyses that verify that deviations in individual input parameters will not likely yield substantially different results.

Please review the document and determine if it addresses the likely impacts from the expansion, and covers the items we've discussed with the company in the past several meetings and conference calls. Please do an initial, fast completeness review within the next few days and tell me of any obvious omissions or deficiencies so I can advise the company.

Also enclosed is a separate document (6 p.) Echo Bay delivered which shows a comparison of seasonal groundwater levels in shallow wells, and the correlation with seasonal flow variations in Wolf Camp spring. High flows in the spring appear to correlate directly with seasonal rise of groundwater in the wells.

Enclosures

George Brown

MAR-130 89-0139
9608 (139)

March 16, 1989

MEMO

To: Tom Olsen, MV-930
Paul Summers, MARSC-310
Marvin Knadle, BPA-OMA-USS

From: George Brown, Spokane District

Subject: Lamefoot Mine - plan modification review

Echo Bay delivered the impact evaluation document today. Please note that the document is inappropriately title "Worst Case Impact Evaluation for the Proposed Interim Expansion for the Lamefoot Mine."

BLM's concern was that previous studies and models by Echo Bay focused on the most favorable conditions that could be reached, while treating to omit or downplay data and test results that indicated the operations could possibly result in greater impacts. In addition, actual site conditions during mining deviated substantially from the conditions predicted in previous studies (i.e., more potentially acid generating waste rock, greater hydraulic conductivity in fractures). As a result, BLM required Echo Bay to use all the actual test results, data and probable post-closure conditions to identify the reasonable range of impacts that are likely to occur as a result of the expansion. Echo Bay refers to BLM's requirement as a "worst case", whereas the conditions addressed are actually for the most probable case.

The hydrogeology evaluation is supposed to identify any preferential pathways for groundwater movement, and the actual groundwater elevation at present, which includes the actual drawdown impacts from existing mine workings and underground exploration drilling.

The groundwater modeling model is supposed to evaluate the likely groundwater drawdown that will result from outflow through the crown pillar and faults/fractures, the potential impacts to wetlands during operations from drawdown, the potential post-closure drawdown area that may influence geochemistry and groundwater quality, and the potential post-closure outflow pathways for groundwater movement.

The geochemical model is supposed to evaluate the effect mining on post-closure groundwater quality, based on the amount of potentially acid generating (PAG) rock in the crown pillar and wall rock, the actual amount backfilling to date with PAG waste rock, plus the additional PAG waste rock to be excavated and backfilled from the expansion. The model is supposed to consider the effect of mine workings being exposed to oxidation periodically within the post-closure groundwater drawdown area. The geochemical evaluation is supposed to evaluate the impact of transport outside the project area.

The models are supposed to include sensitivity analyses that verify that deviations in individual input parameters will not likely yield substantially different results.

Please review the document and determine if it addresses the likely impacts from the expansion, and cover the items we've discussed with the company in the past several meetings and conference calls. Please do an initial, fast completeness review within the next few days and tell me of any obvious omissions or deficiencies so I can advise the company.

Also enclosed is a separate document (6 p.) Echo Bay delivered which shows a comparison of seasonal groundwater levels in shallow wells, and the correlation with seasonal flow variations in Wolf Creek spring. High flow in the spring appear to correlate directly with seasonal rise of groundwater in the wells.

Enclosures

Date	Flume VHM	Flow(gpm)	Avg. Flow (gpm)
04/15/94	0.41	48.11	18.04
04/22/94	0.415	49.65	18.04
04/29/94	0.415	49.65	18.04
05/06/94	0.4	45.14	18.04
05/11/94	0.4	45.14	18.04
05/18/94	0.38	39.54	18.04
05/25/94	0.375	38.23	18.04
06/01/94	0.375	38.23	18.04
06/08/94	0.37	36.91	18.04
06/15/94	0.35	31.98	18.04
06/22/94	0.34	29.68	18.04
06/29/94	0.33	27.43	18.04
07/06/94	0.31	23.33	18.04
07/13/94	0.29	19.69	18.04
07/20/94	0.275	17.18	18.04
07/27/94	0.26	14.85	18.04
08/03/94	0.25	13.42	18.04
08/10/94	0.235	11.45	18.04
08/17/94	0.225	10.24	18.04
08/24/94	0.22	9.55	18.04
08/31/94	0.205	8.05	18.04
09/07/94	0.19	6.61	18.04
09/14/94	0.175	5.36	18.04
09/21/94	0.17	4.96	18.04
09/28/94	0.15	3.58	18.04
10/05/94	0.145	3.3	18.04
10/12/94	0.13	2.43	18.04
10/19/94	0.125	2.25	18.04
10/26/94	0.135	2.75	18.04
11/02/94	0.135	2.75	18.04
11/09/94	0.115	1.82	18.04
11/16/94	0.11	1.61	18.04
11/23/94	0.095	1.11	18.04
11/29/94	0.1	1.26	18.04
11/30/94	0.1	1.26	18.04
12/07/94	0.1	1.26	18.04
12/14/94	0.1	1.26	18.04
12/21/94	0.1	1.26	18.04
12/28/94	0.1	1.26	18.04
01/04/95	0.1	1.26	18.04
01/11/95	0.1	1.26	18.04
01/18/95	0.1	1.26	18.04
01/25/95	0.1	1.26	18.04
02/01/95	0.1	1.26	18.04
02/08/95	0.14	3.01	18.04
02/15/95	0.125	2.25	18.04
02/22/95	0.18	5.75	18.04
03/01/95	0.19	6.61	18.04
03/08/95	0.2	7.54	18.04
03/15/95	0.25	13.42	18.04
03/22/95	0.26	14.85	18.04
03/29/95	0.43	54.39	18.04
04/05/95	0.425	52.79	18.04

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04/12/95	0.42	51.19	18.04
04/19/95	0.42	51.19	18.04
04/26/95	0.41	48.11	18.04
05/03/95	0.4	45.14	18.04
05/10/95	0.4	45.14	18.04
05/17/95	0.38	39.54	18.04
05/24/95	0.37	36.91	18.04
05/31/95	0.36	34.39	18.04
06/07/95	0.36	34.39	18.04
06/14/95	0.33	27.48	18.04
06/21/95	0.32	25.38	18.04
06/28/95	0.31	23.38	18.04
07/05/95	0.29	16.96	18.04
07/12/95	0.27	16.37	18.04
07/19/95	0.25	13.42	18.04
07/27/95	0.25	13.42	18.04
08/04/95	0.24	12	18.04
08/10/95	0.22	9.6	18.04
08/15/95	0.21	8.56	18.04
08/23/95	0.2	7.5	18.04
08/29/95	0.19	6.6	18.04
09/07/95	0.17	4.96	18.04
09/12/95	0.163	4.24	18.04
09/20/95	0.151	3.5	18.04
09/28/95	0.151	3.5	18.04
10/05/95	0.146	3	18.04
10/11/95	0.131	2.48	18.04
10/17/95	0.12	2.02	18.04
10/23/95	0.12	2.02	18.04
11/03/95	0.11	1.61	18.04
11/08/95	0.11	1.61	18.04
11/15/95	0.1	1.26	18.04
11/21/95	0.1	1.26	18.04
11/30/95	0.11	1.61	18.04
12/06/95	0.1	1.26	18.04
12/14/95	0.1	1.26	18.04
01/03/96	0.1255	2.25	18.04
01/10/96	0.1	1.26	18.04
01/17/96	0.11	1.61	18.04
01/24/96	0.12	2.02	18.04
01/29/96	0.12	2.02	18.04
02/07/96	0.11	1.61	18.04
02/14/96	0.11	1.61	18.04
02/21/96	0.17	4.96	18.04
02/28/96	0.17	4.96	18.04
03/06/96	0.18	5.75	18.04
03/13/96	0.27	16.37	18.04
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04/03/96	0.41	48.11	18.04
04/10/96	0.41	48.11	18.04
04/15/96	0.41	48.11	18.04
04/25/96	0.39	42.28	18.04
04/29/96	0.38	39.54	18.04

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05/02/96	0.38	39.54	18.04
05/09/96	0.38	39.54	18.04
05/17/96	0.36	34.39	18.04
05/24/96	0.46	64.73	18.04
05/30/96	0.47	68.42	18.04
06/07/96	0.45	61.16	18.04
06/14/96	0.43	54.39	18.04
06/18/96	0.41	48.11	18.04
06/25/96	0.41	48.11	18.04
07/03/96	0.39	42.28	18.04
07/08/96	0.38	39.54	18.04
07/17/96	0.36	34.39	18.04
07/24/96	0.34	29.68	18.04
07/30/96	0.33	27.48	18.04
08/06/96	0.29	19.69	18.04
08/14/96	0.265	14.85	18.04
08/23/96	0.25	13.42	18.04
08/29/96	0.24	12.08	18.04
09/05/96	0.22	9.6	18.04
09/12/96	0.21	8.56	18.04
09/19/96	0.19	6.6	18.04
09/27/96	0.17	4.96	18.04
10/02/96	0.17	4.96	18.04
10/08/96	0.16	4.24	18.04
10/16/96	0.15	3.58	18.04
10/30/96	0.14	3.01	18.04
11/05/96	0.13	2.48	18.04
11/12/96	0.13	2.48	18.04
11/21/96	0.13	2.48	18.04
11/27/96	0.13	2.48	18.04
12/04/96	0.13	2.48	18.04
12/10/96	0.1	1.26	18.04
12/18/96	0.1	1.26	18.04
12/27/96	0.12	2.02	18.04
01/02/97	0.13	2.48	18.04
01/08/97	0.13	2.48	18.04
01/16/97	0.13	2.48	18.04
01/23/97	0.12	2.02	18.04
01/29/97	0.12	2.02	18.04
02/07/97	0.11	1.61	18.04
02/11/97	0.11	1.61	18.04
02/19/97	0.11	1.61	18.04
02/26/97	0.13	2.48	18.04
03/07/97	0.14	3.01	18.04
03/13/97	0.19	6.61	18.04
03/19/97	0.25	13.42	18.04
03/26/97	0.45	61.16	18.04
04/01/97	0.46	64.73	18.04
04/10/97	0.46	64.73	18.04
04/17/97	0.44	57.71	18.04
04/24/97	0.44	57.71	18.04
05/02/97	0.45	61.16	18.04
05/06/97	0.41	48.11	18.04
05/14/97	0.39	42.28	18.04

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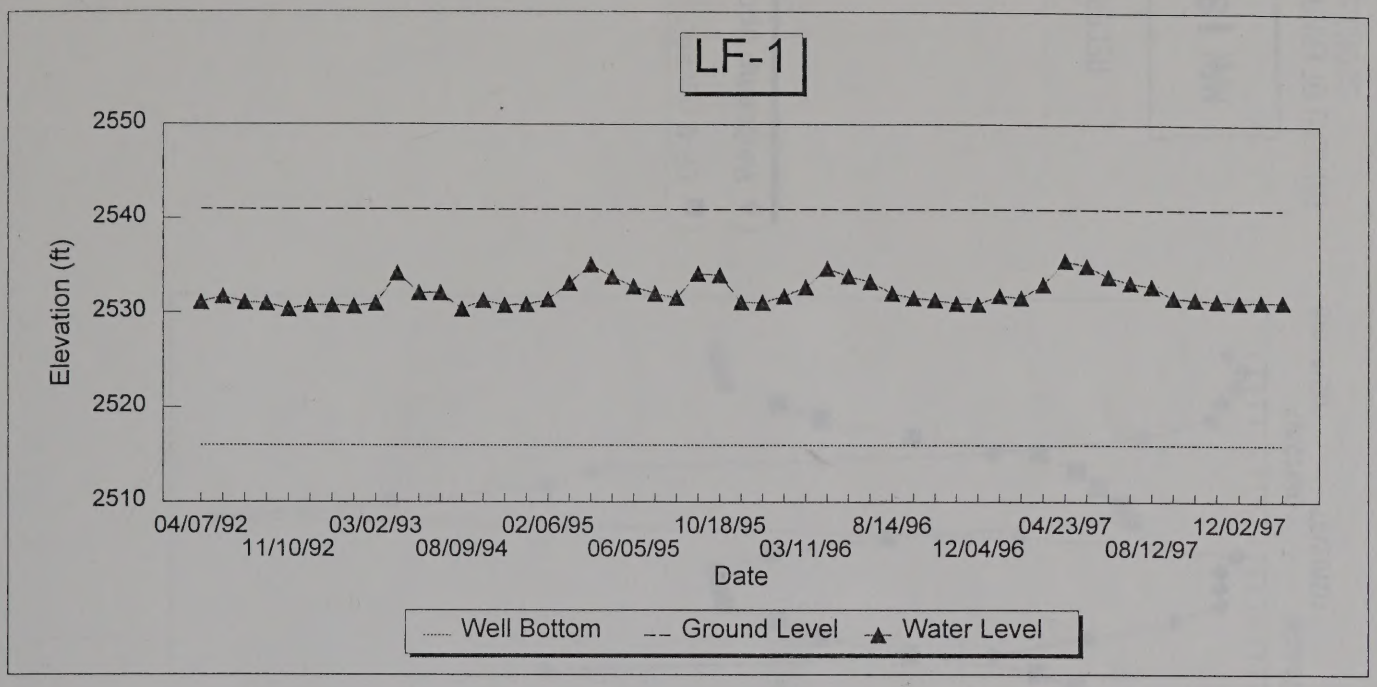
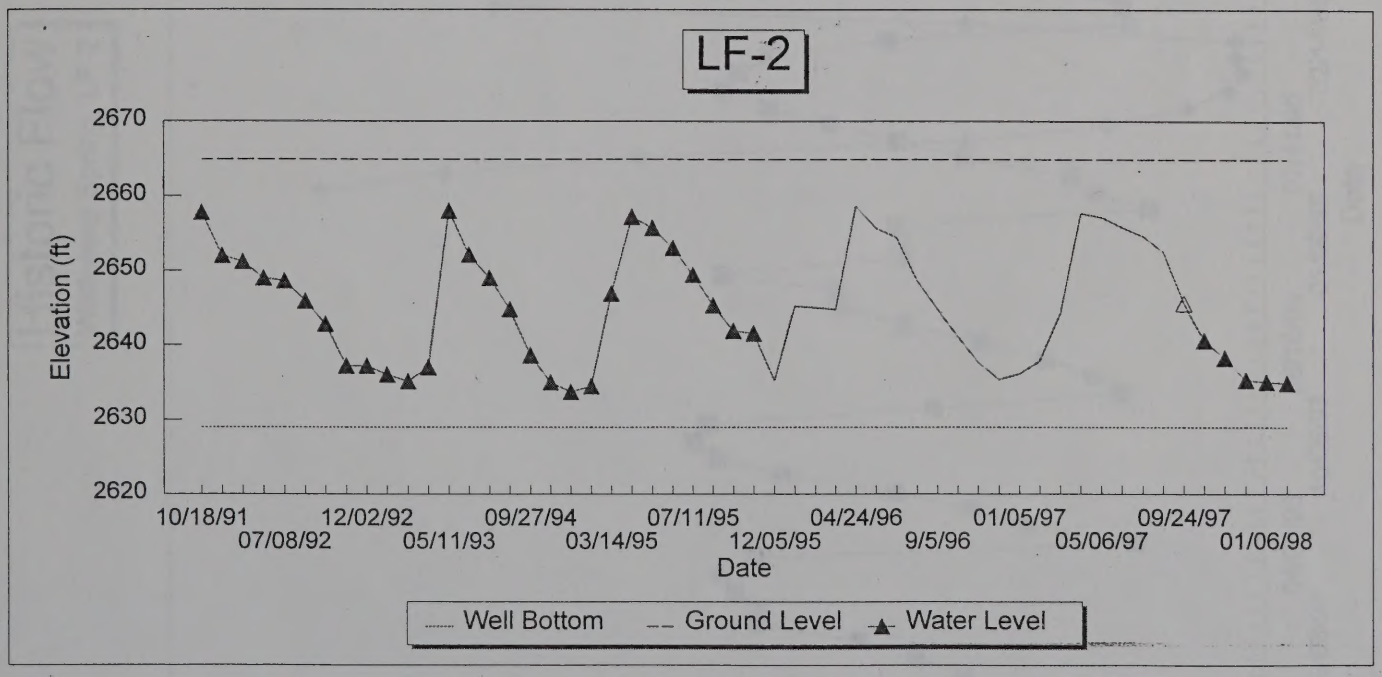
05/21/97	0.39	42.28	18.04
05/27/97	0.39	42.28	18.04
06/04/97	0.39	42.28	18.04
06/11/97	0.38	39.54	18.04
06/20/97	0.38	39.54	18.04
06/25/97	0.38	39.54	18.04
06/30/97	0.38	39.54	18.04
07/03/97	0.37	36.91	18.04
07/10/97	0.37	36.91	18.04
07/16/97	0.35	31.98	18.04
07/24/97	0.33	27.48	18.04
08/06/97	0.27	16.37	18.04
08/14/97	0.26	14.85	18.04
08/20/97	0.26	14.85	18.04
08/28/97	0.24	12.08	18.04
09/04/97	0.23	10.82	18.04
09/11/97	0.22	9.6	18.04
09/19/97	0.21	8.56	18.04
09/25/97	0.19	6.61	18.04
10/01/97	0.18	5.75	18.04
10/08/97	0.17	4.96	18.04
10/16/97	0.16	4.24	18.04
10/22/97	0.15	3.58	18.04
10/28/97	0.14	3.01	18.04
11/07/97	0.13	2.48	18.04
11/13/97	0.13	2.48	18.04
11/20/97	0.12	2.02	18.04
11/26/97	0.12	2.02	18.04
12/04/97	0.12	2.02	18.04
12/10/97	0.12	2.02	18.04
12/18/97	0.12	2.02	18.04
12/23/97	0.11	1.61	18.04
12/31/97	0.1	1.26	18.04
01/07/98	0.1	1.26	18.04
01/15/98	0.1	1.26	18.04
01/21/98	0.1	1.26	18.04
01/29/98	0.1	1.26	18.04
02/12/98	0.12	2.02	18.04
02/17/98	0.13	2.48	18.04

Figure 1
Ground Water Elevations





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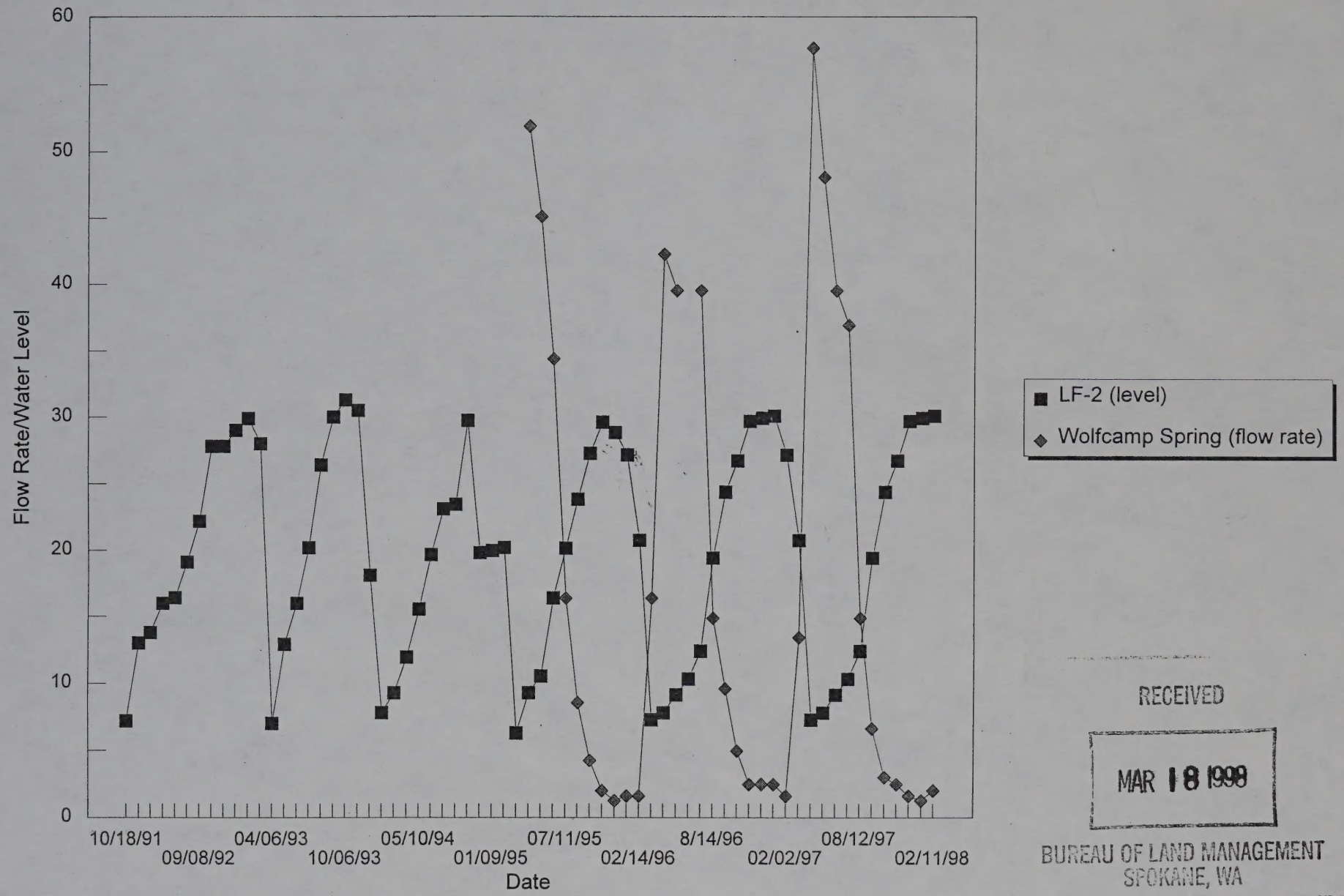
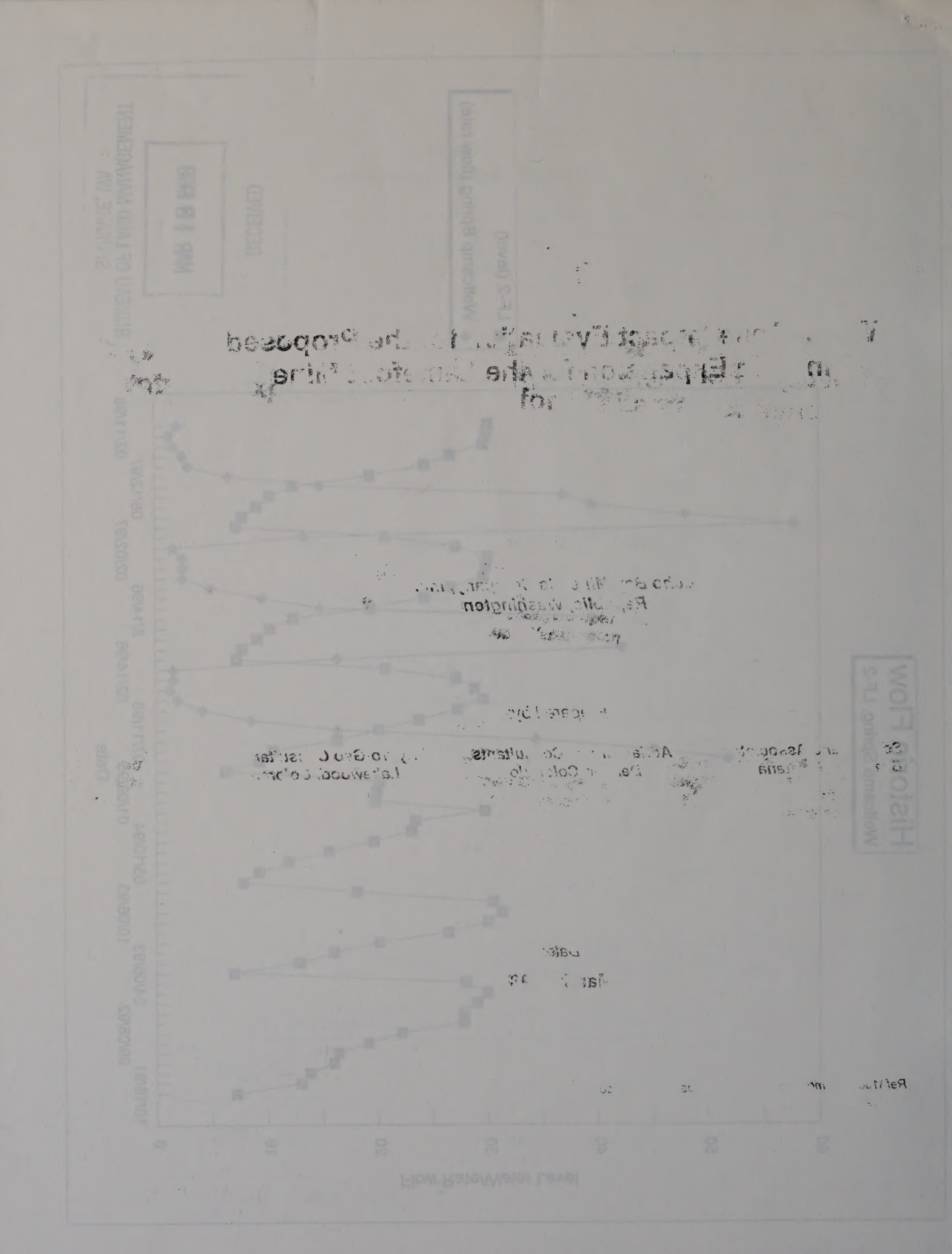
Historic Flow

Wolfcamp Spring, LF-2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